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PROPOSED PLAN OF MINING AND RECLAMATION

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TROY PROJECT
ASARCO INC.
LINCOLN COUNTY, MONTANA

Volume I

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UNITED STATES FOREST SERVICE
KOOTENAI NATIONAL FOREST

STATE OF MONTANA
DEPARTMENT OF STATE LANDS

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DRAFT
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED PLAN OF MINING AND RECLAMATION

TROY PROJECT - ASARCO

LINCOLN COUNTY, MONTANA

Prepared by

Montana Department of State Lands

U.S. Forest Service, Kootenai National Forest

Commissioner
Montana Department of State Lands

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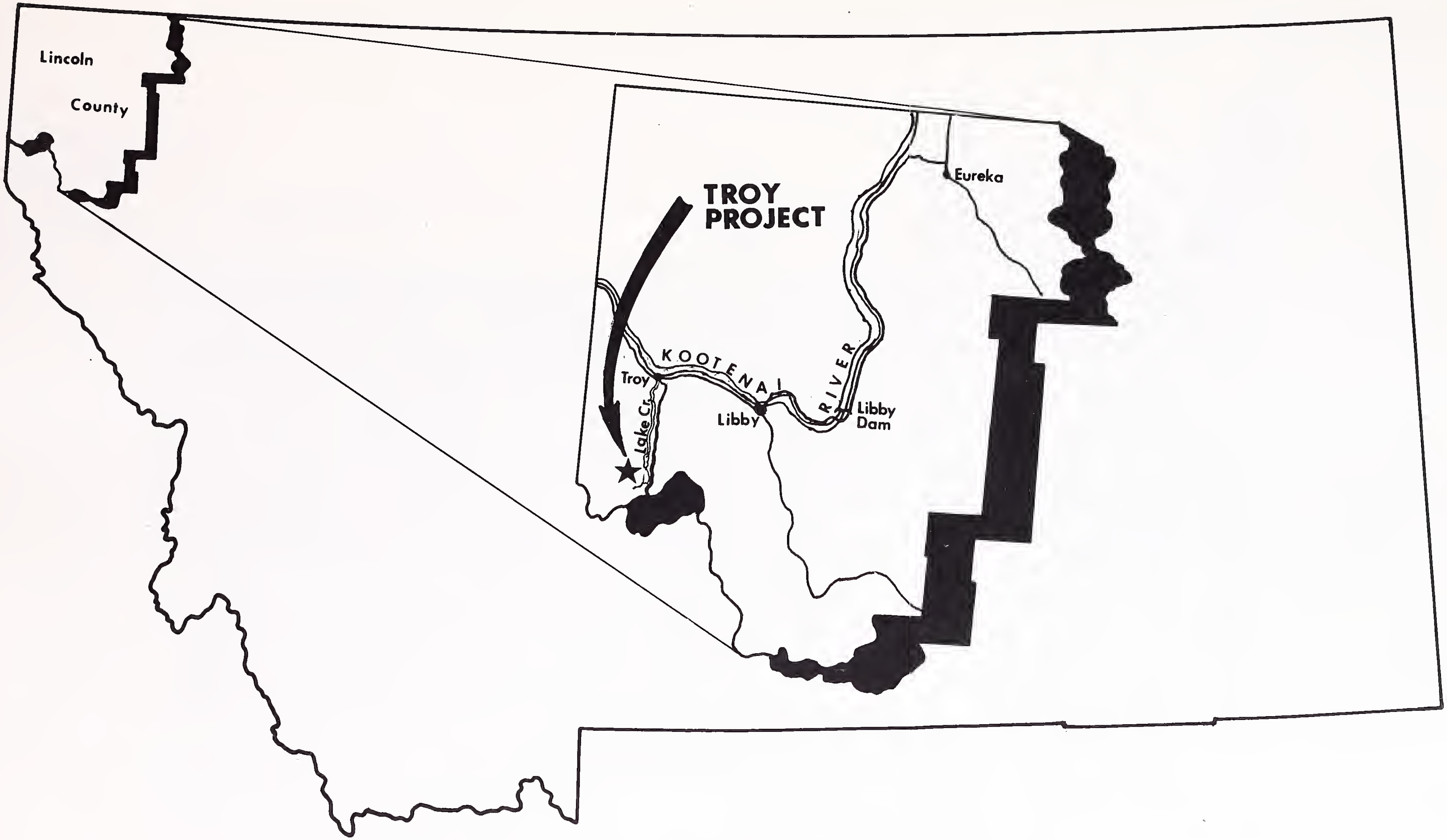

GENERAL LOCATION MAP

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INTRODUCTION

Preface

This statement was prepared by the U. S. Forest Service (Kootenai National Forest) and the Montana Department of State Lands (lead state agency) and represents a joint analysis of broad cumulative environmental impacts of a proposed new copper and silver resource development by ASARCO Inc., in an area adjacent to Bull Lake in Lincoln County, Montana. The joint statement considers the primary, secondary and cumulative impacts of the ASARCO Inc. proposal.

ASARCO Inc. is a major world producer of nonferrous metals and is involved extensively in the worldwide exploration for, mining, smelting and refining of these metals (principally ores containing copper, lead, zinc and silver). ASARCO Inc., also has substantial involvement with the exploration, mining and development of nonmetal minerals as well as the production of industrial chemicals.

In February, 1976, ASARCO Inc. communicated to the Montana Department of State Lands (Department) and the Kootenai National Forest (USFS) plans for submission of permit applications for the development of the Mt. Vernon copper-silver deposit near Bull Lake in Lincoln County, Montana. A notice of intent to conduct mining operations on national forest lands was received by the Kootenai National Forest February 17, 1976. In addition, ASARCO Inc. issued a news release of its intent to file for all state and federal permits necessary to develop the Mt. Vernon deposit. ASARCO Inc. subsequently submitted to the Department and the USFS for review a copy of the Stearns-Roger Report, a baseline environmental study for the Mt. Vernon area compiled at the request of ASARCO Inc. during 1973 and 1974 by Stearns and Roger, a Denver based consulting organization.

ASARCO Inc. filed a hard rock operating permit application with the Department May 17, 1976. A plan of operations for the Troy Project was received by the Department and the USFS on the same date. On June 2, 1976, ASARCO Inc. was notified by the Department that additional information was necessary for a complete operating permit application. Recognizing that at that time (1) the regulations pursuant to the Hard Rock Law required that a hard rock operating permit must be granted or denied within 60 days following the receipt of a complete application and that (2) the project was of a controversial nature and major scope, the Department entered into negotiations with ASARCO Inc. and requested an extension of the 60-day time period.[1]

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[1] Prior to passage of an amendment to the Hard Rock Act by the 1977 Legislature (HB 1977) in which the 60-day time period for departmental action on a complete hard rock operating permit application was changed to a negotiable period of one to 365 days in addition to the initial 60-day time period.

In September, 1976, the Department and the USFS agreed to participate jointly in the preparation of an environmental impact statement for the Troy Project. The agreement, however, was contingent upon the Department obtaining an extension of the 60-day time period.

An agreement was reached in October, 1976, between the Department and ASARCO Inc. providing for an 18 month period during which the Department would prepare an EIS and take final action on ASARCO's hard rock operating permit application. Work on the EIS commenced November 1, 1976.

As a result of the Department's request for additional information needed to complete ASARCO's operating permit application, ASARCO Inc. filed a mining and reclamation plan with the Department on December 13, 1976. ASARCO, however, omitted from the plan information pertaining to the mill site and tail impoundment, contending that the Hard Rock Law did not extend Departmental permit jurisdiction to these areas. The Department notified ASARCO that, pending clarification of an earlier Attorney General's opinion regarding the matter of tailings impoundments, concentrator sites and the Hard Rock Law, a Departmental ruling on the completeness of the Troy Project permit application could not be made. An opinion from the Attorney General was received May 24, 1977, in which it was stated that the Troy Project mill, concentrator and tailing impoundment were included in the jurisdiction of the Hard Rock Law. As a result, the Department notified ASARCO Inc. that the Troy Project operating permit application remained incomplete.

On September 6, 1977, ASARCO, Inc. filed with the Department of State Lands a Petition for Declaratory Ruling in which ASARCO requested the Department to rule that the mine mouth concentrator is not subject to the provisions of Chapter 12, Title 50, RCM 1947, the Montana Hard Rock Act. On July 25, 1977, the Commissioner of State Lands issued an order denying the Petition for Declaratory Ruling.

On August 30, 1977, ASARCO, Inc. filed in District Court in Lewis and Clark County a declaratory judgment action in which ASARCO, Inc. petitioned the court to enter a judgment declaring that the proposed concentrator, slurry pipeline, tailing pond and associated facilities are not subject to regulation under the Hard Rock Law. That lawsuit is presently pending.

Wishing to insure that the draft EIS for the proposed Troy Project contained a full year of baseline data from the project area, ASARCO Inc., in November, 1977, granted the Department an additional three months to complete the impact statement. Completion of the Final Environmental Impact Statement for the proposed Troy Project is scheduled for August 1, 1978.

Agency Responsibilities and Interagency Relationships

Responsibilities of Montana State Agencies

Department of State Lands

The Montana Board of Land Commissioners[1] (Board) and Montana Department of State Lands[2] (Department) are responsible for the administration of the MONTANA HARD ROCK LAW (Title 50, Chapter 12, RCM 1947). Pursuant to its duties as administering agency for the HARD ROCK LAW, the Department must review and then grant or deny a Hard Rock-mine permit or permit amendment within a period negotiable with the applicant to be not less than 60 days, nor more than 425 days after the submission of a complete permit application. The Department reviews applications for conformance with provisions of the Hard Rock Law regarding the method of operation, water control, air quality, mine waste disposal, topsoiling and for the reclamation of lands affected by the proposed mining operations. The Board may adopt rules to accomplish the purpose of the Hard Rock Law, and the Department may adopt rules with respect to the filing of reports and the issuance of permits. To insure compliance with the Hard Rock Law and rules adopted pursuant to the Law, the Department is required to make mine inspections and investigations as necessary.

The Department may not approve Hard Rock-mining in areas which meet the criteria for selective denial provisions as specified in Section 50-1214 of the Hard Rock Law. The Department may conduct studies or encourage others to conduct studies of Hard Rock-mining and Hard Rock-mining Land Reclamation.

When the operator is not in compliance with requirements of the Hard Rock Law, rules pursuant to the Law, or orders of the Department and has not achieved compliance within time limits set by the Department, the commissioner shall serve a notice of noncompliance on the operator, or if necessary, he shall order the suspension of the permit. After a hearing, the Board shall order the Department to revoke the permit if requirements specified in the notice of noncompliance, in the order of suspension, or if an order of the Board requiring remedial measures have not been satisfied.

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[1] The Board of Land Commissioners consists of the Governor, Attorney General, Superintendent of Public Instruction, State Auditor and Secretary of State.

[2] The Commissioner of State Lands is the chief administrative officer for the Department of State Lands and is appointed by and serves at the pleasure of the Governor.

Department of Natural Resources and Conservation

The Montana Department of Natural Resources and Conservation (DNRC) is charged with administration of the Montana Water Use Act. The Act is the statutory foundation of Montana's water law and became effective July 1, 1973. Objectives of the Act are three: 1) to institute a permit system for the appropriation of surface and groundwater in Montana; 2) to provide a procedure for the legal determination all existing water rights and 3) to establish a system of centralized records of all water rights in the state.

For a new surface water diversion or impoundment, or a well with an anticipated beneficial use of more than 100 gallons per minute, an "Application for Beneficial Water Use Permit" must be applied for and received before construction is begun or water is diverted. This form is used to describe the intended use, location, amount of water and purpose of the proposed project. It is anticipated that the ASARCO Troy Project will necessitate three such permit applications involving 1) the deep wells for makeup water along Stanley Creek, 2) the collection sump along upper Stanley Creek for potable water and 3) the appropriation of mine water for in-mill use. Following a public notice procedure (the application is advertised in appropriate newspapers once a week for three consecutive weeks, after which follows an objection period of one month) and a hearing if necessary, the Department issues a Permit, provided that criteria contained in the Montana Water Use Act are met.

The Department must take final action on a beneficial water use permit within 180 days after the last date of public notice if a hearing is held, and 120 days if no hearing is held.

For wells or developed springs with a beneficial use of less than 100 gallons per minute, a "Notice of Completion of Groundwater Development of Less Than 100 Gallons Per Minute" form must be submitted to the Department together with a filing fee within 60 days of the spring or well development. Following a review of the form, the Department sends a certificate of water right to the local county clerk and recorder who records the information and forwards the certificate to the well owner. In the case of a well, a "Well Log Report" must also be completed and submitted to the Department by the licensed well driller.

Prior to the construction and operation of certain utility facilities within the State of Montana, an application must be made to DNRC for a Certificate of Environmental Compatability and Public Need. Applications made before April, 21, 1975 were filed in conformance with the Montana Utility Siting Act of 1973. Effective April 21, 1975 the Act was revised and renamed the Montana Major Facilities Siting Act.

The approximately 17 miles of 115 kilovolt above ground electric transmission line proposed to be built for the ASARCO Troy Project is covered by the Act. Following an application to DNRC, a one-year study period is provided by the Act. Within one year following receipt of the application DNRC recommends to the Board of Natural Resources and Conservation whether the facility should be certified. The final decision rests with the Board.

Northern Lights Inc., a Sandpoint, Idaho, based REA Co-op serving northern Idaho and northwestern Montana, filed an application for the Troy Project 115 kilovolt transmission line on December 30, 1977. Because of time constraints, the entire environmental analysis for the line as mandated by the Montana Major Facilities Siting Act will not occur in this EIS. Portions of this EIS, however, completed by DNRC under contract to DSL and concerning selected impacts of the applicants preferred 115 kilovolt transmission line route will be ultimately used by DNRC in preparing a separate EIS for the transmission line. Transmission line impact analysis provided by DNRC and included in this EIS include: 1) wildlife, 2) fisheries, 3) vegetation, 4) soils and slope stability and 5) aesthetics. Additional subjects to be considered in the future DNRC EIS include: 1) transmission line construction and design criteria, 2) need and 3) analysis of alternative corridors for the line, and 4) alternative power sources.

Montana Department of Highways

ASARCO's proposal to construct a mine access road requires access to State Highway Route 202. The Montana Department of Highways is designated the custodian of such highways by Section 32-2202, RCM 1947. This access requires an Approach Permit approved by the Montana Department of Highways, the Montana Highway Commission and the Federal Highway Administration.

In making decisions on highway actions the Department of Highways must comply with the Montana Environmental Policy Act, the National Environmental Policy Act, and the Federal Highway Administration regulations concerning public hearings, both location and design of highways and environmental impact statements.

No action will be taken by the Department of Highways until the Operating Permit for the proposed ASARCO Mt. Vernon mine has been approved by Federal and State authorities.

Montana Department of Health and Environmental Services

The Air Quality Bureau of the Department of Health and Environmental Sciences has primary responsibility for air pollution control activities in the state of Montana. These responsibilities include the review of new sources of air pollution to be located in the state, enforcing standards and ensuring that Federal standards are achieved and maintained.

The Montana Clean Air Act (Title 69, Chapter 39, RCM 1947) provides rule making authority to the Board of Health in regard to permits (Section 69-3911). This rule making authority was exercised by the adoption of rule MAC 16-2.14(1)-S1400, Permits, Construction and Operation of Equipment. This rule provides that, prior to the construction or operation of any new or modified equipment of certain categories, a permit be obtained from the Department of Health, Air Quality Bureau. In the instant case, ASARCO's crusher and concentrator are the subject facilities and will be required to obtain a construction permit. This EIS will serve in large part as the review basis for ASARCO's construction permit request.

In addition to the permits required, various facilities of the development will be subject to certain emission standards as contained in the Administrative Records of Montana. The primary regulated sources would be the crushers and concentrator, and the emissions of most concern that of particulate matter.

The Air Quality Bureau is also charged with achieving and maintaining both the state and federal ambient air quality standards. The Montana State Implementation Plan describes the state's efforts in achieving and maintaining federal ambient air quality standards. One requirement of this plan is that it provide for the achievement and maintenance of federal primary ambient air quality standards by 1975 and for achievement and maintenance of the secondary standards as soon thereafter as is practicable. In many areas of the state, and of the nation, the strategies to achieve the standard have not accomplished their desired result, i. e., achievement of the standard, but such achievement remains a primary goal of the agency.

On January 18, 1974, the Board of Health and Environmental Sciences adopted a rule, MAC 16-2.14(10-S14460, entitled the Montana Pollutant Discharge Elimination System (MPDES). This rule provided program elements needed by the State to administer a waste discharge permit program in the State of Montana. Section 4 of MAC 16-2.14(10)-S14460 states in part:

> *(c) "The owner or operator of any proposed point source, which may discharge pollutants into state waters, shall file a completed MPDES permit application no less than 180 days prior to the day on which it is desired to commence operation of the point source . . ."*

Section 69-4806 of RCM 1947 states in part: *"It is unlawful to:*

> *(2) carry on any of the following activities without a current permit from the Department:*
>
> *(a) construct, modify, or operate a disposal system which discharges to any state waters;*
>
> *(b) construct or use any outlet for discharge of sewage, industrial waste, or other waste to state waters; or*
>
> *(c) discharge sewage, industrial waste, or other waste into any state waters;"*

ASARCO Inc., on January 18, 1978, applied to the Department of Health and Environmental Sciences for an MPDES permit to discharge subterranean water from the proposed mine adit in Lincoln County, Montana.

As specified in MAC 16-2.14(10)-S14460, application for an MPDES permit, for new or expanded point sources, must be made at least 180 days prior to that date upon which it is desired to commence discharging from the point source. The Department is required to public notice its intent to issue or deny an MPDES permit for a period of at least 30 days. If the Department feels that there is sufficient public interest in the proposed action, the Department will schedule a public hearing on the matter and public notice its intent to hold the hearing. Such public notice shall occur at least 30 days prior to the date of the hearing. Upon consideration of all comments and testimony received during the public notice period(s) and public hearing, the Department will make its final decision to issue or deny the MPDES permit.

MPDES permits may be issued for a term not to exceed five years. If the permittee wishes to continue to discharge beyond the expiration date of the permit, he must apply to the Department for renewal of the permit. Such application must be made at least 180 days prior to the expiration date of the permit. The Department must follow the same public notification and other procedures for renewals as for original applications.

The Department has several enforcement options available to it to force compliance with the conditions of MPDES permits. Sections 69-4820, 69-4820.1, 69-4823, 69-4824, 69-4824.1 and 69-4825 of RCM 1947 present the various enforcement options available to the Department.

Relationships among State Agencies

Four State Agencies, the Department of State Lands, Department of Highways, the Department of Health and Environmental Sciences and the Department of Natural Resources and Conservation, have decisions to make in regard to the ASARCO Inc. proposal that require environmental review under the Montana Environmental Policy Act. These four agencies are cooperating in this impact statement to fulfill their MEPA obligations. The Department of Fish and Game, and Department of Community Affairs do not have a decision to make which requires review under MEPA, but are cooperating in preparation of this impact statement to help anticipate and solve possible problems in regard to the ASARCO Inc. proposal.

Responsibilities of and Relationships Between Federal Agencies

Forest Service - B. L. M. - U. S. B. M.

The responsibility for managing the mineral resources relating to the General Mining Law of 1872 is with the Secretary of Interior. The B. L. M. has redelegated certain functions of the administration of mining claims on National Forest System lands to the Forest Service. The Forest Service administers these claims under Regulations 36 CFR parts 251, 252 and 293, which cover prospecting, exploration and mining activity on the National Forest System by persons operating under the United States Mining Laws of May 10, 1872, as amended (30 USC 22).

The 1872 General Mining Laws and its principal amendment of July 23, 1955 allows any prospector, who discovers what he believes to be a valuable mineral deposit on "public domain" National Forests, to locate and work a mining claim.

Organic Administration Act of 1897 states that persons have statutory rights, not a mere privilege, to enter upon National Forests for the purposes of prospecting and mining. These rights cannot be unreasonably restricted or made excessively burdensome.

Since 1872, laws have been passed by Congress that affect, but do not diminish, the rights granted the miner under the General Mining Law. These are:

1) The Antiquities Act of 1906 (34 stat 1225).

2) The Multiple Use Mining Act of 07/23/55 (69 stat 367).

3) The National Historic Preservation Act of 1966 (30 stat 915).

4) The National Environmental Protection Act of 01/01/70.

5) The Clean Air Act (42 USC 1857).

6) The Federal Water Pollution Control Act of 1972 (33 USC 1151).

7) The Solid Waste Disposal Act (42 USC 3251 - 3259).

8) The Rare and Endangered Species Act of 12/28/73 (18 stat 884).

9) The Federal Land Policy and Management Act of 10/26/76 (90 stat 2243).

United States Department of Agriculture Rules on Prospecting, Exploration and Mining procedures (effective 09/01/74) sets forth rules and procedures to minimize adverse environmental impacts on National Forest surface resources. However, these rules do not provide for the management of mineral resources. Such responsibility lies with the Department of Interior.

The ASARCO proposal for development consists of 24 patented mining claims and 424 unpatented mining claims. Bear Creek Mining Company has the fee title to the mining claims. Rights on the unpatented claims are split with the mining companies having the mineral rights and the Forest Service the surface rights.

The surface rights on unpatented mining claims are managed under the U. S. Department of Agriculture Rules for National Forest Surface Use Under U. S. Mining Laws (Title 36, CFR, Section 252.1-252.15). facility location, construction and operation are administered under the rules governing operating plans (Section 252.4), approval of operating plans (Section 252.5), Inspection (Section 252.7), Requirements for environmental protection (Section 252.8), Maintenance during operations (Section 252.9) and Access (Section 252.12). Bonding of the operation as well as project cessation and reclamation are covered in Sections 252.13 and 252.10 .

These rules allow for Forest Service approval of the access road, slurry pipeline, water return line, mill site and related structures when detailed plans are submitted and meet the environmental protection and safety standards.

The transmission line to the project mill site will be handled as a special use permit and approved separate from the mine and mill facilities with operating plan.

The objective of the Forest Service is to integrate the development and use of mineral resources with the use and conservation of all other forest resources to the fullest extent possible under the laws governing mineral disposal. This embodies the concept of multiple use in its broadest sense.

Forest Service policy is:

1) To cooperate actively with the Bureau of Land Management to administer the mining and mineral leasing laws on lands administered

by the Forest Service.

2) To take appropriate action to protect the interest of the United States by requiring prospectors and mining claimants to comply with the mining laws and to prevent unauthorized uses on mining claims.

3) To issue permits and leases for mineral disposal or consent to the issuance of permits or leases by the Bureau of Land Management as authorized by law and when such disposal is in the public interest. Damages will be weighed against benefits to be derived when considering the public interest. All mineral permits or leases issued by the Forest Service or for which consent is given will prohibit unnecessary disturbance of the surface and will provide for reasonable restoration of the surface.

Relationships between State and Federal Agencies

The primary objective of this cooperative impact statement is to fulfill both State and Federal Agencies' requirements under NEPA and MEPA. The relationship between State and Federal Agencies, therefore, has been one of voluntary cooperation rather than one dictated by statute or other mandate.

I. DESCRIPTION OF TROY PROJECT MINING PROPOSAL

A. Proposal of ASARCO Incorporated

1. Background

a. Purpose

ASARCO Inc. proposes to develop and mine approximately 48 million tons of a stratabound deposit of copper-silver ore over a 19 year period, hereafter known as the Troy Project Mine. Approximately three years would be required to develop the project. Mining is projected to occur for approximately 16 years thereafter. A conceptual project schedule for the ASARCO Project is shown in Figure I-1. Mine development and construction of associated facilities cannot begin pending issuance of a final joint State-Federal Environmental Impact Statement and securance by ASARCO of all necessary Federal, State and local approvals.

The project area lies in the Lake Creek drainage of the Bull Lake Valley, Lincoln County, Montana (Figure I-2). Ore would be milled at a plant site near the mine and resulting copper-silver concentrate (about 60,000 tons annually) would be transported by truck to a railroad facility in the nearby town of Troy. Concentrate would then be loaded into rail cars and transported to a copper smelter where it would be sold for smelting.

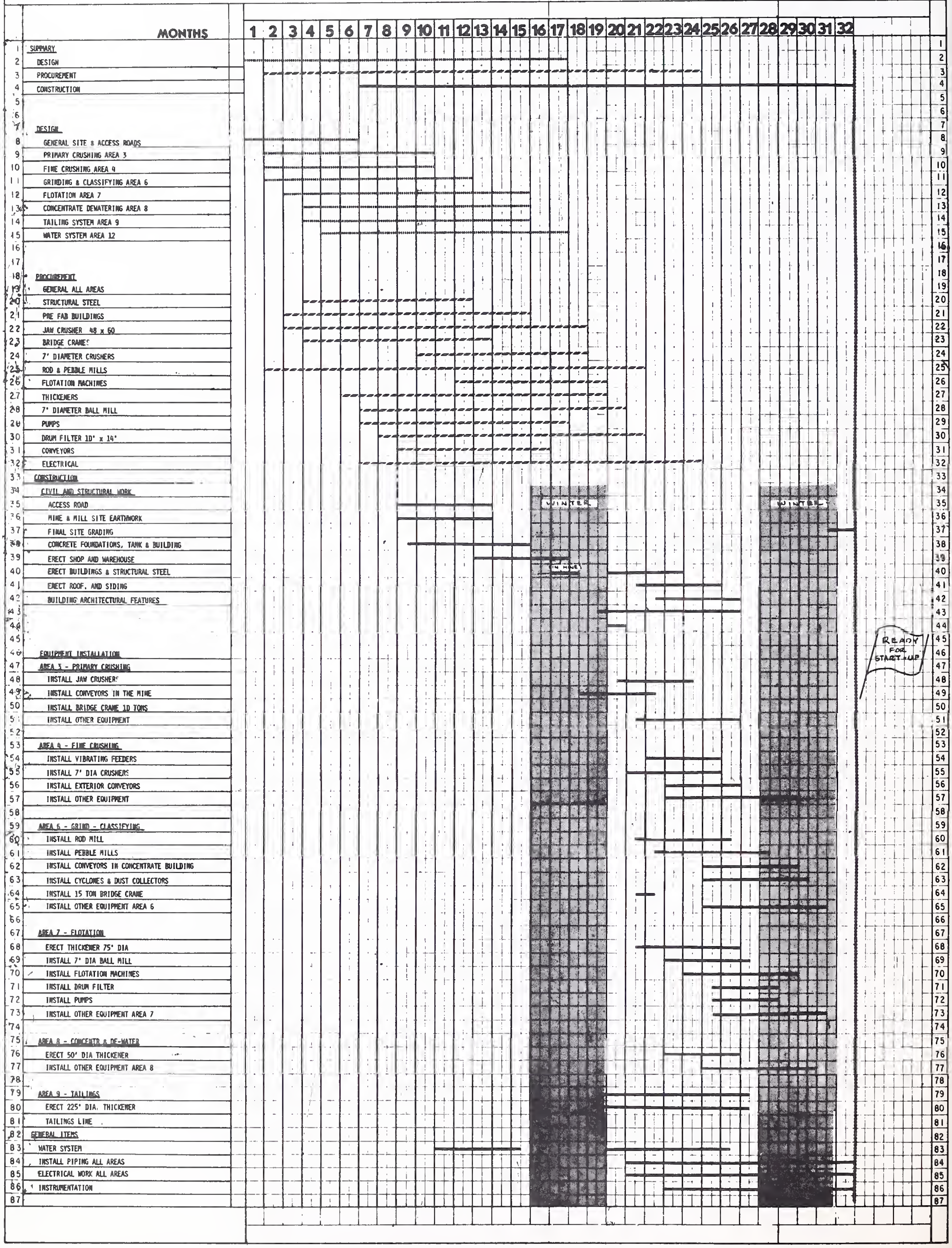
The resulting waste, called tailing, would be produced at a rate of 2,930,000 tons per year and would be transported in slurry, through pipeline, to a tailing impoundment area for water recovery.

b. History

The earliest known mineral location in the project area occurred during the late 1940's and was made by an unknown prospector who dug and then abandoned a prospect hole in copper-bearing Revett Quartzite on the south slope of Mt. Vernon. In 1963, C. A. Weare and associates located six claims around the prospect hole. E. B. Williams located 55 claims along a pyrite-bearing quartz vein outcrop in a small canyon on the north side of Mt. Vernon in 1957. Personnel from the Bear Creek Mining Company (a subsidiary of Kennecott Copper Corporation) inspected this vein in 1959. In 1963, Bear Creek Mining Company sampled the south fork of Stanley Creek to the outcrop as part of a regional reconnaissance program in search of Belt-Age stratiform copper deposits. Results were encouraging; options were taken on the Weare and Williams claims, and funds were granted for an exploratory drill hole. Additional exploratory drilling occurred in 1964 and the Mt. Vernon ore body was subsequently delineated. Additional work included the construction of roads in 1968 on the north and south slopes of Mt. Vernon to aid in the excavation of adits. Information from the adits confirmed drilling results and aided

Figure I-1.

PROPOSED PROJECT SCHEDULE
TROY PROJECT - PHASE III
FOR
ASARCO



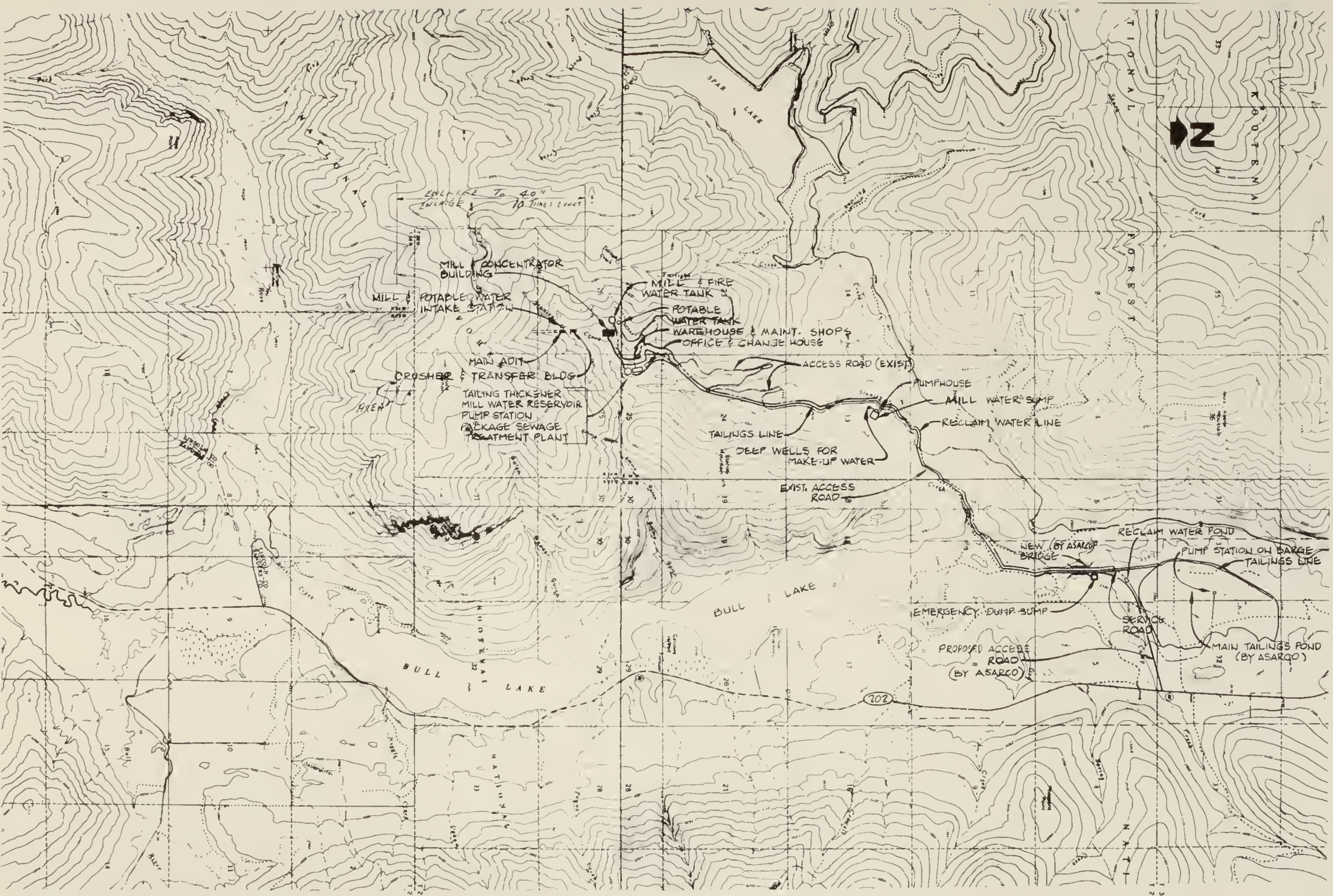


Figure I-2. ASARCO Troy Project site and facilities location

FACILITIES LOCATION PLAN
SCALE 1" = 2000'

in the excavation of bulk metallurgical samples for engineering studies.

Approximately 8,000 tons of material have been removed from the north adit. A total equivalent heading advance of 1,546 feet of 7 foot by 9 foot drift was driven between September 11, 1967 and November 29, 1967. A total of 2,438 feet of diamond drilling was done within the ore body from October 1, 1967 to December 16, 1967.

Approximately 63,000 tons of material was removed from the south adit from November 1968 to December 1969. A total equivalent heading advance of 5,437 feet of 10 foot by 14 foot drift was completed, as was approximately 12,000 feet of underground diamond drilling.

During 1970 and 1971, Bear Creek Mining Company continued a very limited rotary drill hole program to obtain structural data for the ore body. In 1972, Kennecott Copper Corporation decided to lease the property to another mining company for development. ASARCO Inc. was the successful bidder.

ASARCO Inc. entered into a Development Agreement with Bear Creek Mining Company during 1973 and has since established environmental and engineering studies aimed at the eventual development of the deposit. Exploratory drilling, involving nine diamond drill holes from the surface and approximately 600 feet of diamond drill holes underground, was undertaken in June 1973. The drilling confirmed the results of Bear Creek Mining Company. In August 1973, ASARCO commissioned Stearns-Roger, Inc. to begin a year's environmental study in the Mt. Vernon area for the purpose of providing baseline information. A report of this study was completed in February 1975.

c. Location

The Troy Project area is located in Lincoln County, Montana, in the Northwest corner of the state, and includes property controlled or owned by either the U. S. Forest Service, St. Regis Paper Company or ASARCO Inc. (Figure I-3).

The proposed project-mine area lies immediately west of Bull Lake and encompasses a major portion of the Stanley Creek drainage, as well as a portion of the Lake Creek drainage. The proposed project area is approximately 15 miles south of Troy, Montana, and approximately 30 miles southwest of Libby, Montana, the closest communities of appreciable size. State Highway 202, running north-south, borders the east side of the project area.

Acreage which would be directly affected by the project is located in Sections 31 and 32, T30N, R33W; in Sections 5, 6 and 7, T29N, R33W; in Sections 12, 13, 14, 23, 24, 25, 26, 35 and 36, T29N, R34W; and in Sections 5 and 6, T28N, R34W, Montana Principal Meridian (M. P. M.).

The project is located on 424 unpatented and 24 patented mining claims located in the name of Bear Creek Mining Company, or on private property owned by either St. Regis Paper Company or ASARCO Inc.

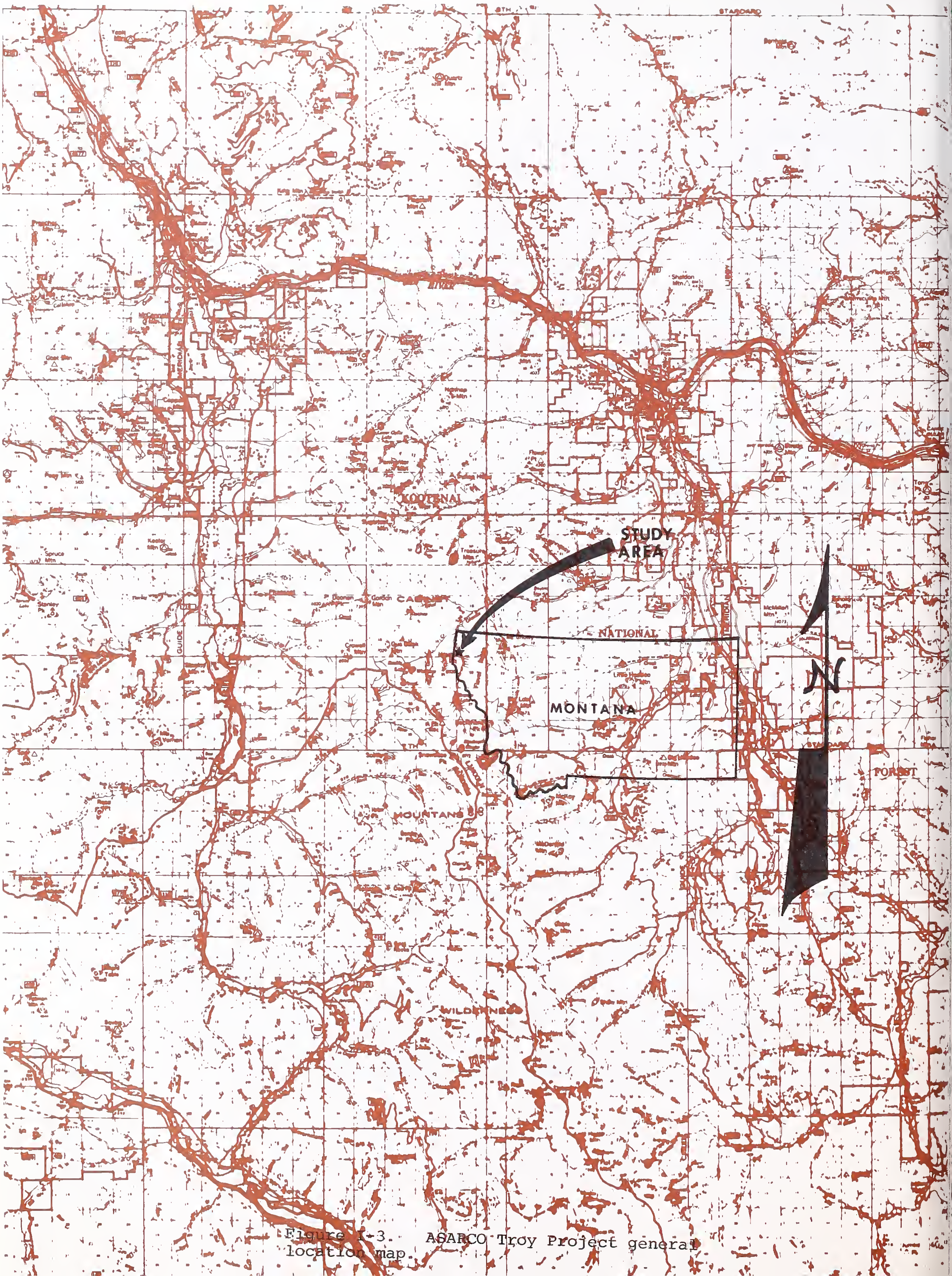


Figure I-3. ASARCO Troy Project general location map.

d. Description of the Ore Body

The Troy ore body is a copper-silver stratabound deposit, located in the upper part of the Precambrian Revett quartzite. Located beneath Mt. Vernon at the 4,400 foot elevation, the deposit outcrops lie on the northeast and southwest slopes with a North 5o West trend. The ore zone is about 7,400 feet long, 1,800 feet wide, and averages 60 feet in thickness, with dips to the southwest ranging from 0 to 15 percent. Approximately 48 million tons of the 64 million-ton deposit are recoverable by room-and-pillar mining.

The quartzite bed containing 0.74 percent copper and 1.54 oz. per ton silver is mineralized with chalcocite, bornite, chalcopyrite, some oxide copper and native silver.

Two major faults are associated with the deposit. The east fault, striking north-north-west, is the east boundary of the ore body. The cross fault, striking east-west, cuts the ore body, with two-thirds of the deposit occurring to the north and one-third to the south (Figure I-4). This reverse fault dips 70^0 to the south, while the north block drops approximately 210 feet below the south block.

e. Delineation of the Ore Body

As previously stated, in 1963, Bear Creek Mining Company (a subsidiary of Kennecott Copper Corporation) sampled the south fork of Stanley Creek as part of a regional reconnaissance program in search of Belt-Age stratiform copper deposits. Chip-sampling results indicated interesting copper and silver concentrations in quartzite beds in the top 250 feet of the Revett formation. An exploratory drill hole revealed good grade ore intercepts over 60 feet in one quartzite unit; as a result a more extensive drilling and mapping program was begun in 1964. The drilling indicated a deposit approximately 2,000 feet wide and 60 feet in thickness, with an unknown length. The copper-bearing quartzite beds on the south slope of Mt. Vernon were discovered during the mapping, and it was believed to be the south end of the deposit, thus indicating a length of more than 8,000 feet. In the summer of 1966, drilling began along the course of the mineralized zone, and by July 1967 the property was passed to Bear Creek Mining Company acquired all claims in the area by option or by location. By September 1969, a total of 93 diamond drill holes and approximately 5,000 feet of exploration drifting had been completed, delineating the 1800 by 7400 by 60 foot thick ore body containing approximately 64,000,000 tons of ore.

Following lease of the mining property by ASARCO Inc., an additional 9 diamond drill holes were drilled from the surface and approximately 600 feet of diamond drill holes were drilled underground to confirm the results of Kennecott Copper Corporation.

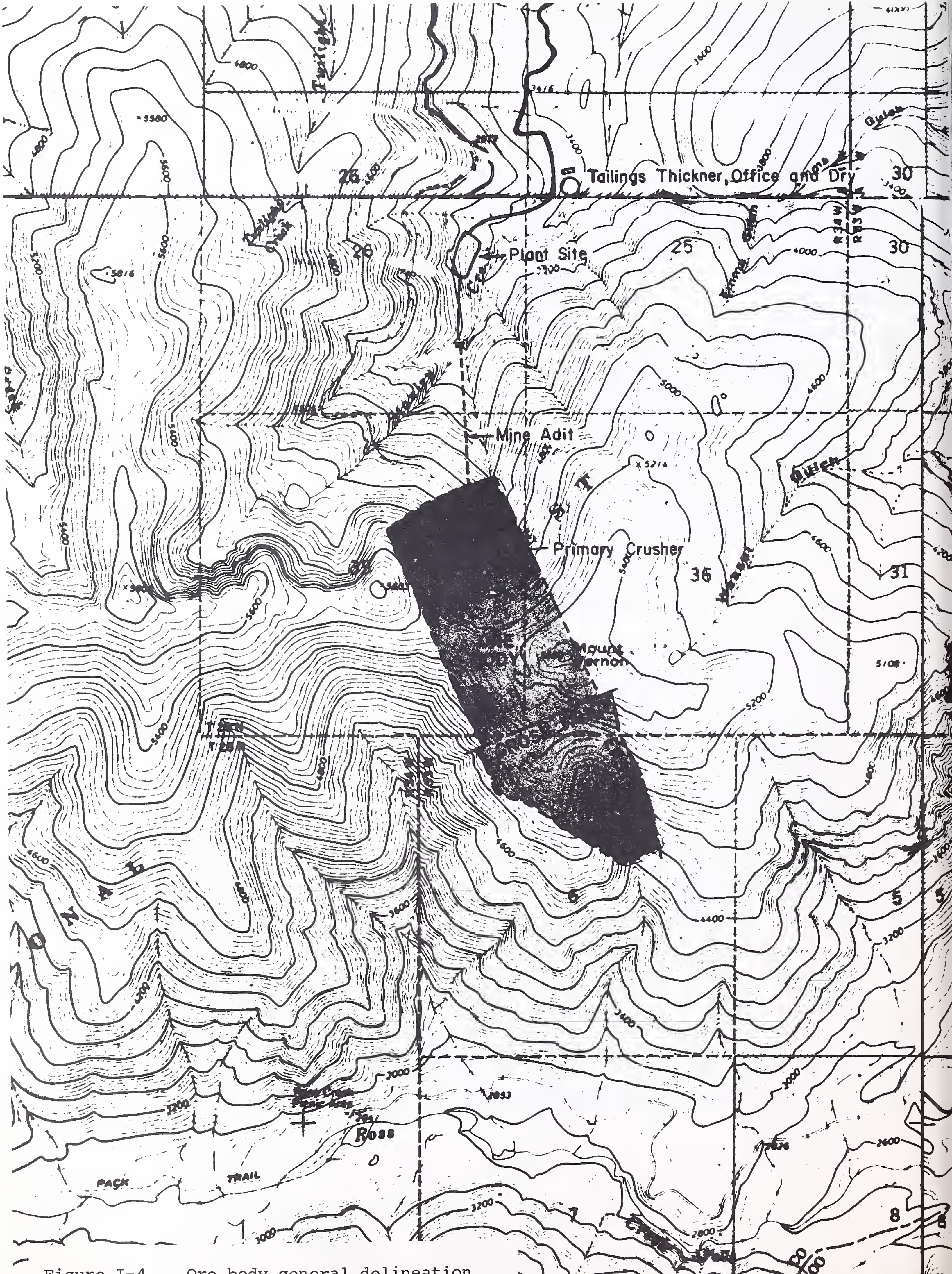


Figure I-4. Ore body general delineation

2. Mine Development

Mine development would consist of a 15 by 30 foot adit driven at +13 percent from the plant site patio to the underground ore body where a primary crusher would be located (Figures I-5 and I-15). Waste rock would be excavated from the adit, sumps and crusher room, a portion of which would be utilized in the plant construction. The remainder would be used in the constructing subgrade of the plant site and access road.

A main ventilation exhaust adit would be driven from the north slope of Mt. Vernon at approximately the 4,400 elevation thus intersecting the 15 by 30 foot adit in the ore body. Development of the exhaust ventilation adit would require the addition of approximately 31,000 tons of waste to the existing dump at the north portal; final configuration of this dump would be approximately 160 feet high with slopes at the natural angle of repose. Waste materials from the mine would vary from three quarters of an inch to 24 inches in size. When mine development becomes completed, two ventilation intake adits would be excavated to the ground surface from within the mine. Surface disturbance would be limited to slightly more than the 15 by 20 foot cross section of the portal opening.

Existing roads would be utilized to service the mine adits above the 3,700 foot elevation and surface disturbance would be limited to the portal openings and storage patio at the exhaust adit. The existing road over the top of Mt. Vernon from the north to the south adit would be maintained for access to the south adit. The south adit would be maintained and incorporated in the mine ventilation system as mining progressed from the north to the south ore block.

3. Mining Sequence

Once both the mine development stage and the construction of the associated facilities have been completed, mining of the ore body using a room-and-pillar method would begin. Room-and-pillar mining, as previously stated, involves excavation of rooms within the ore body so that pillars of ore are left to support the overburden (Figure I-6). It is possible that a variation of room-and-pillar mining known as slot mining would be used in addition to room-and-pillar methods. Slot mining would incorporate an elongate semi-continuous wall of ore to separate the rooms rather than a series of pillars.

The ore body averages 60 feet in thickness. Rock mechanics tests indicate that spans of up to 75 feet between pillars may be safely excavated. However, initially a one to one room-to-pillar ratio would be used; consequently rooms and pillars would be on 60 foot centers. Based on this concept, 75 percent of the 64 million-ton ore reserve would be recoverable over a 16 year mining period with a production rate of three million tons per year. As mining progressed, if the span between pillars could be increased or the size of the pillars decreased, the life of the mine would be extended. Selective removal of pillars, if possible would also increase the mine life (see Chapter VIII).

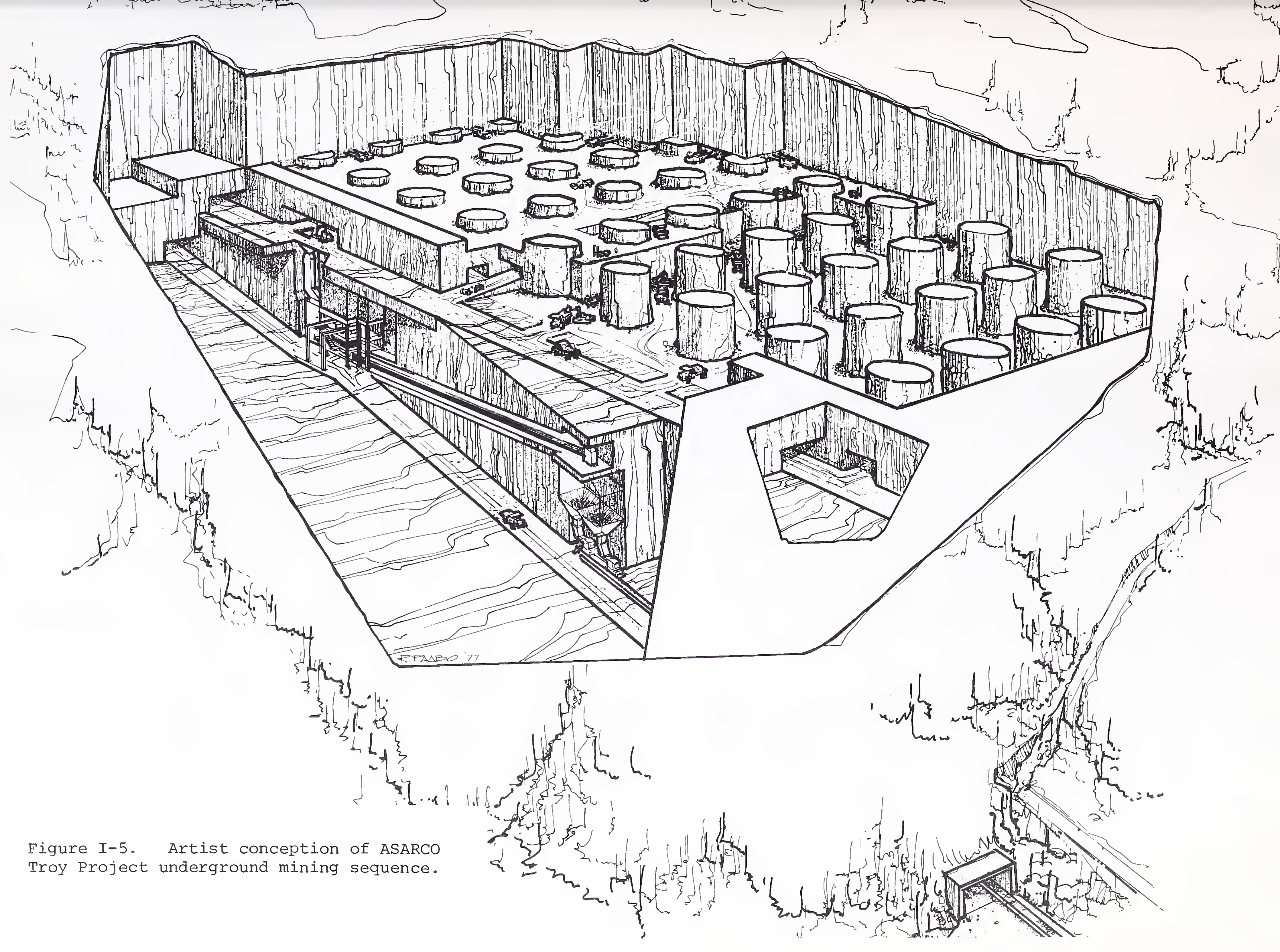


Figure I-5. Artist conception of ASARCO Troy Project underground mining sequence.

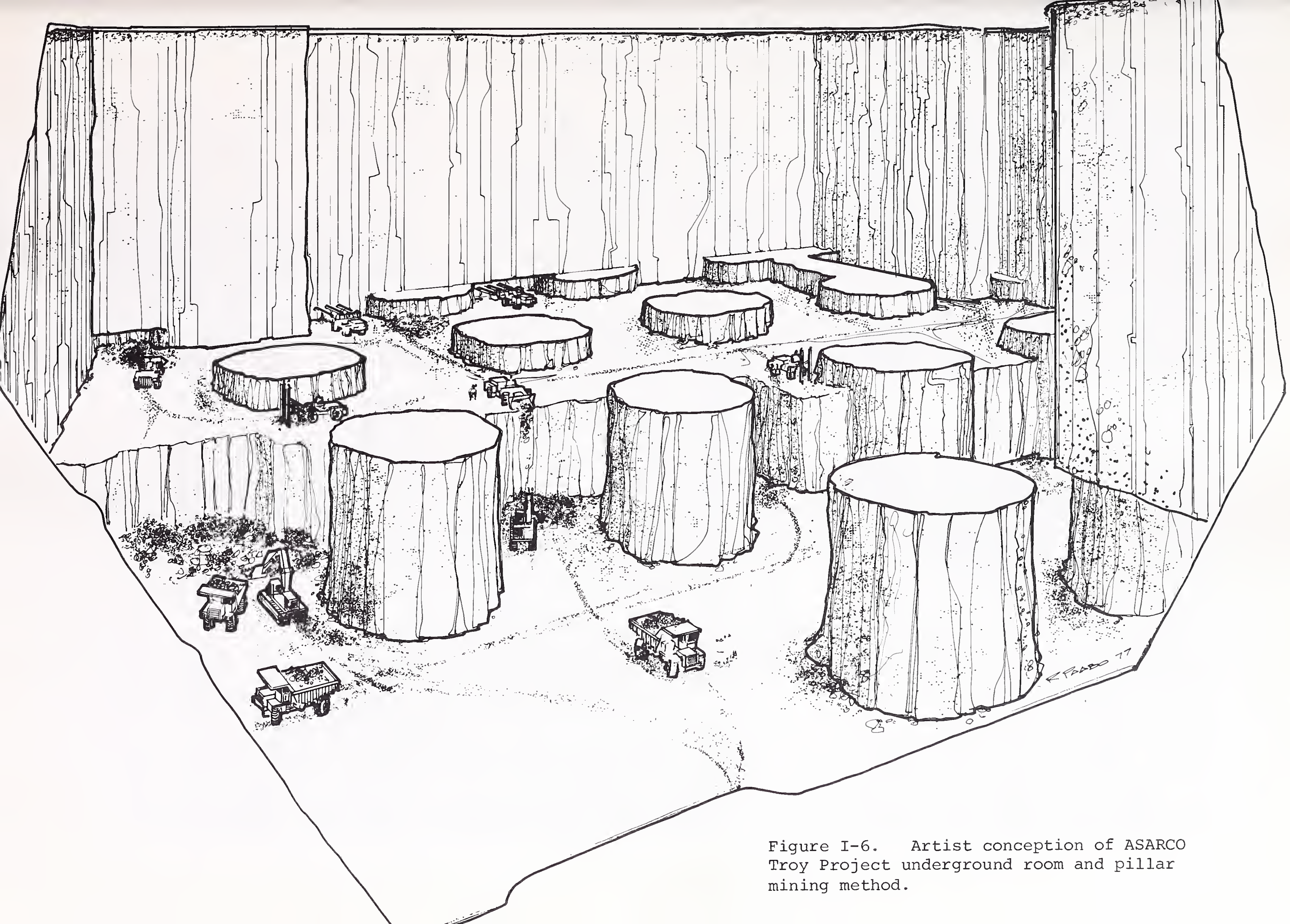


Figure I-6. Artist conception of ASARCO Troy Project underground room and pillar mining method.

The 60 foot thick ore body would be mined by removal of a 14 foot top slice, followed by two consecutive 23 foot benches or possible one bench. The top slice would be drilled horizontally by 3-boom jumbos, with benches drilled vertically by one-machine air tracks. The blasting agent would be, depending on water conditions, either ANFO for dry holes or a water-gel for wet holes. All broken ore would be transported to an underground primary crusher by 13 cubic-yard capacity haul and dump equipment in combination with truck-shovels. Following reduction to a minus seven inch size in the primary crusher, the ore would be transported by conveyor to the coarse ore storage bins. The storage bins would provide a steady supply (surge capacity) to the conveyor system for transport to the secondary crusher and mill site on the surface for further processing.

Mining procedures of the south ore block, uplifted approximately 210 feet, would be identical to those outlined for the north block. An ore pass or truck ramp would be excavated to transport the ore 210 feet down to the north ore body transport system.

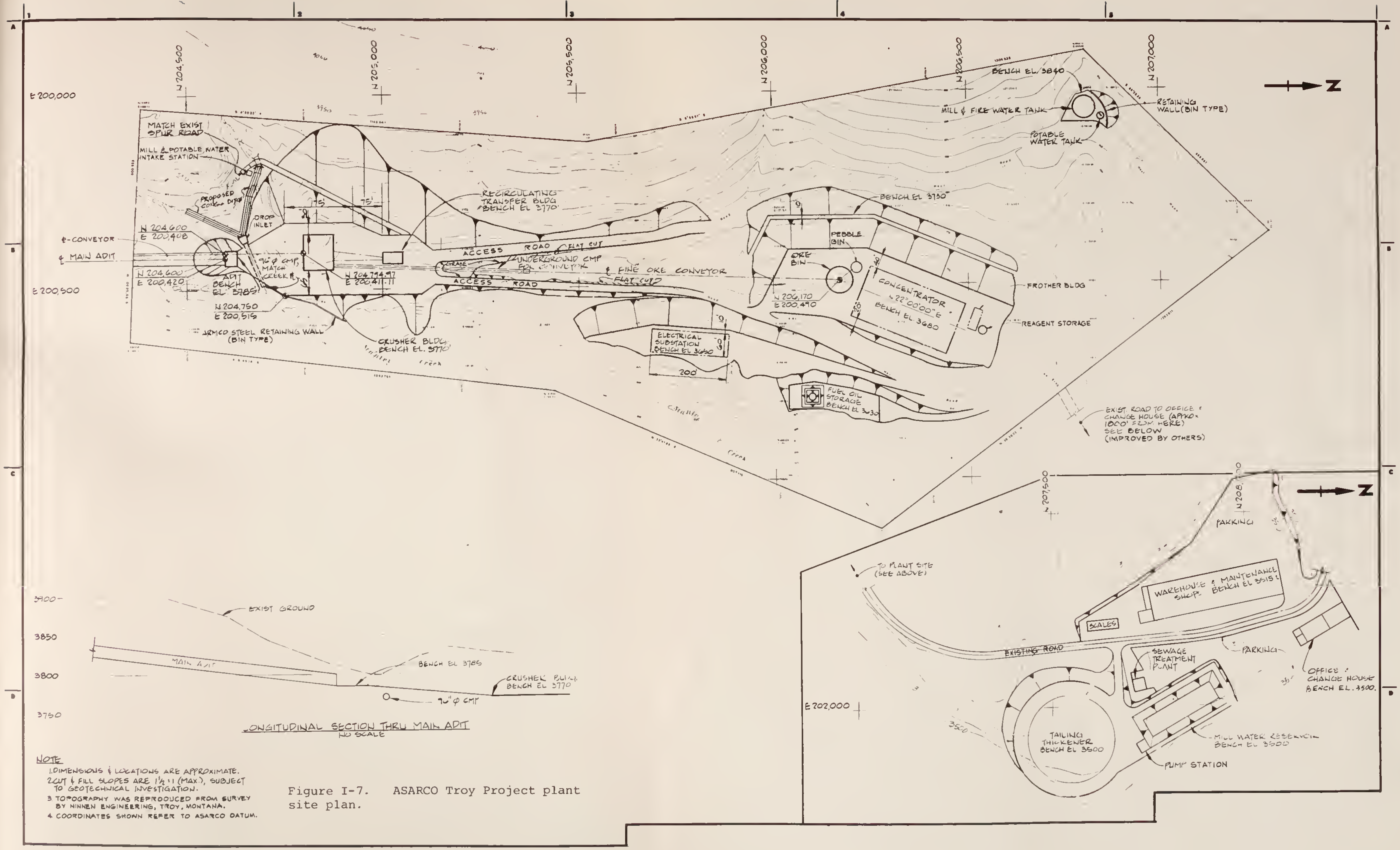
4. Ore Milling and Concentration

An ore mill would be located at the 3,700 foot elevation on the north slope of Mt. Vernon. A general proposed arrangement is shown in Figure I-7, although final configuration will not be known until final engineering studies are complete.

Bulk ore samples have been taken from existing adits in the ore body to establish ratios of concentration, grindability, recoveries, concentrate grade and tailing water quality. Tests indicate that a simple bulk flotation process would achieve acceptable concentration ratios. Ore would not be altered chemically or by any pyrometallurgical technique at the plant site. The milling process (Figure I-8) would be limited to the physical separation of waste material (the eventual tailing) from the desired minerals. In this case, ore which averages 0.74 percent Cu (copper) and 1.54 oz. Ag (silver) per ton would be upgraded to produce a concentrate with values of 33 percent Cu and 70 oz. Ag per ton.

The process would involve reduction of minus seven inch ore delivered from the mine primary crusher to a secondary crushing plant, where it would be reduced in size to minus three-quarter inch material. This product would then be transported by conveyor to the grinding section of the plant, where grinding mills would further reduce the size of the ore to a consistency of fine granular sugar. The material would proceed from there in a slurry form.

Froth flotation would be the final step in the separation process. Here, metered amounts of reagents would be added to the ore slurry in flotation tanks, causing the ore minerals to separate from the waste. The first step in the flotation process would consist of adding chemicals to a slurry of ground ore to promote bubble formation, and then to coat the surface of the desired minerals so that these minerals would



NOTE
1. DIMENSIONS & LOCATIONS ARE APPROXIMATE.
2. CUT & FILL SLOPES ARE 1½ : 1 (MAX.), SUBJECT TO GEOTECHNICAL INVESTIGATION.
3. TOPOGRAPHY WAS REPRODUCED FROM SURVEY BY NINNEN ENGINEERING, TROY, MONTANA.
4. COORDINATES SHOWN REFER TO ASARCO DATUM.

Figure I-7. ASARCO Troy Project plant site plan.

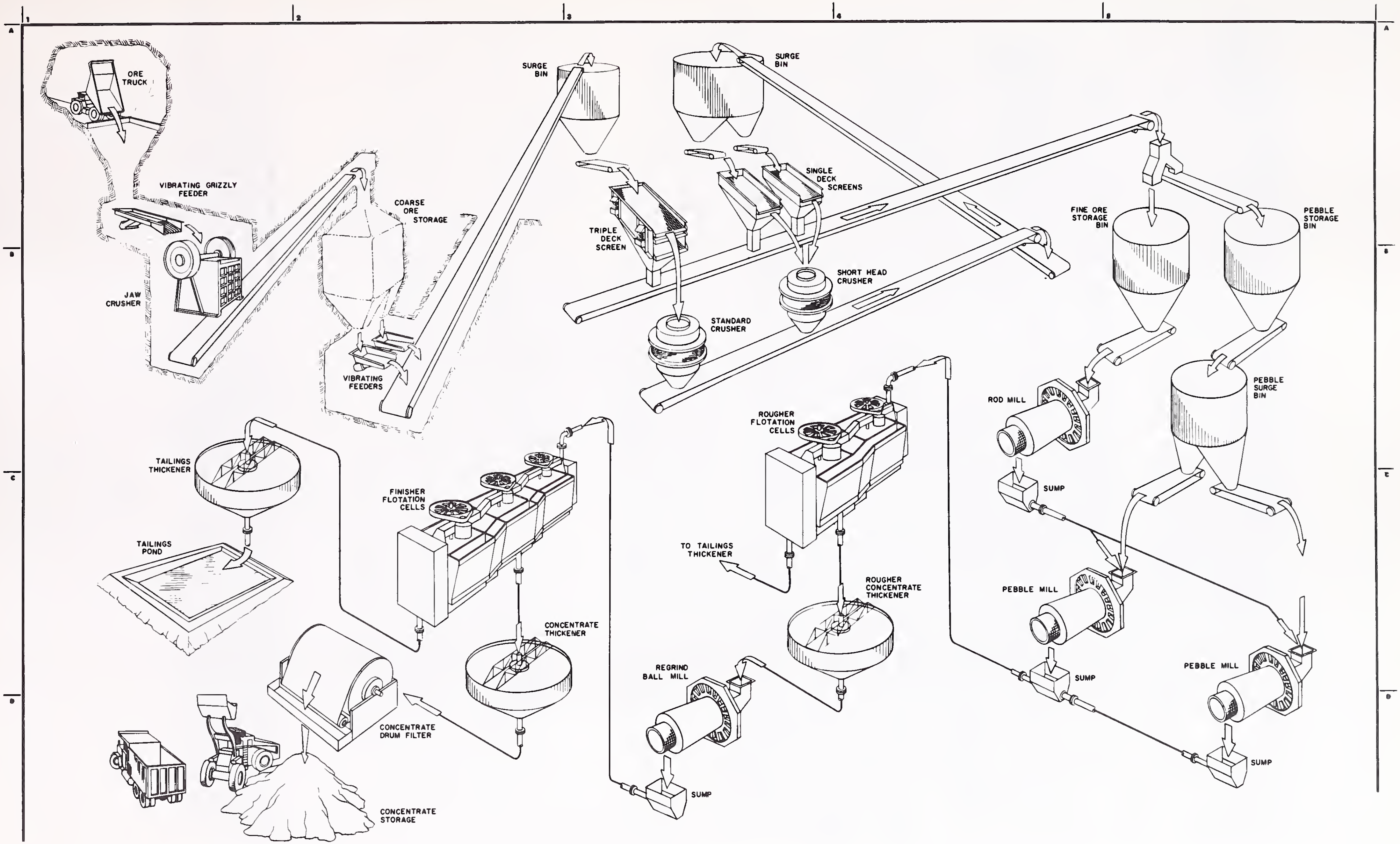


Figure I-8. ASARCO Troy Project pictorial flow diagram for the milling process.

attach themselves to air bubbles. The second step would consist of agitating the ore slurry in the flotation machine and introducing air to form bubbles. The bubbles and desired minerals would then cling together and float to the surface of the slurry where they would be separated from the barren rock particles.

The chemicals (reagents) added to promote bubble formation are called "frothers" and those added to coat the desired mineral particles are called "collectors".

Two frothers, Dowfroth 250 and Pineoil, would be added in equal quantities at the rate of .04 pounds of reagent per ton of ore treated. This would result in an initial concentration in the water portion of the slurry in the flotation cell of approximately 10 parts per million (ppm) each. Since the frothers would tend to migrate to the froth and become removed during flotation, approximately one-half (5 ppm) of each reagent would remain in the water with the tailing.

Amyl xanthate, a collector, would be added at the rate of .09 pounds per ton of ore and would result in an initial concentration in the flotation water of 25 ppm. This reagent is specifically designed to coat those minerals that are scheduled to be removed. As a result, the xanthate would report to the concentrate leaving only a small portion in the tailing water.

Sodium hydrosulfide is a nonsulfide copper mineral collector and would be added only when sufficient nonsulfide copper minerals were present (approximately 25 percent of the time). Sodium hydrosulfide would be added in quantities of up to 3 pounds per ton (initial quantities of 750 ppm in the water).

Reagents would be fed by Clarkson feeders or solenoid valves which open for a certain number of seconds every minute and allow the reagent to flow through a small orifice. The reagents and concentration in the tailing water are estimated as follows:

Reagents	Composition	Quantity in Water
Dowfroth 250	Glycol methyl ether	5 ppm
Pineoil	Terpineol	5 ppm
Xanthate	Potassium amyl xanthate	5 ppm
Sodium hydrosulfide	NAHS	400 ppm

Following the flotation process, the ore, now called concentrate, would be collected and excess water removed in the concentrate thickener. Concentrate from the thickener would then be applied to a revolving vacuum drum for drying. After drying, the concentrate would be stockpiled for hauling. The concentrate would be produced at a rate of 60,000 tons per year, and hauled by truck to Troy for rail shipment to a smelter.

The ore mill would operate at a capacity of 8,500 tons per day on a 24-hour, 7-day schedule. Health and safety standards set by both the Occupational Safety and Health Administration (OSHA) and the Mine Safety Health Administration (MSHA) would be maintained.

5. Transport and Deposition of Tailing

The annual production of tailing from the proposed mine and mill would be approximately 2,930,000 tons. Tailing from the concentrator would flow by gravity, through pipeline, approximately 2,500 feet to a 225 foot-diameter tailing thickener located at the 3,500 foot elevation of Mt. Vernon. After removal of excess water from the tailing in the thickener, the slurry from the thickener would flow by gravity in a tailing pipeline approximately 6½ miles to a tailing impoundment area.

Tailing would be deposited in a 385 acre tailing impoundment located near Lake Creek (Figure I-2 and Figure I-9). The pond would initially consist of a 265 acre impoundment capable of storing approximately three years of tailing production. The impoundment would ultimately be expanded to approximately 385 acres. Deposition of tailing would occur simultaneously at several discharge points along the perimeter of the impoundment. In this manner the coarse fraction of the tailing would be deposited near the perimeter, while the finer fractions and water would migrate to the center portion.

6. Employment Requirements

a. Plant Construction

Total construction manpower is estimated to peak at 220 people, including supervisory personnel for both general and subcontractors involved in the construction process. Mobilization and demobilization of the construction crew is expected to occur gradually, with the peak work force occurring 8 to 13 months after the construction begins. Onsite construction would continue for approximately two years. What portion, if any, of the construction work force may remain as permanent employees is not known.

b. Mine Development

Pre-mine development would be conducted by ASARCO and would encompass a timespan of approximately 1½ years. Development would be concurrent with plant construction. An initial work force of 43 persons would be increased to approximately 100 employees over the development period.

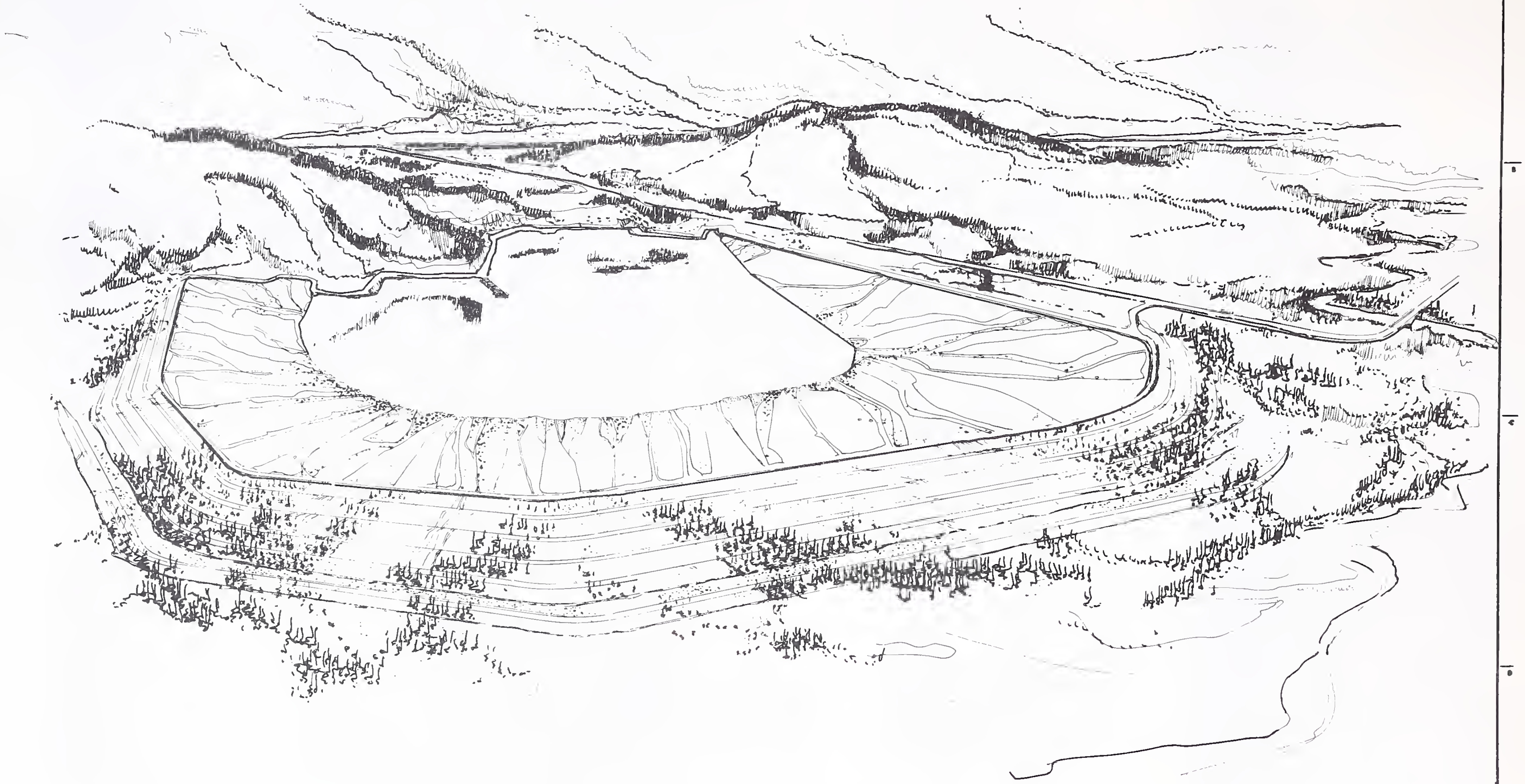


Figure I-9. ASARCO Troy Project artist conception of tailing impoundment area.

c. Production Period

Following development and construction, a limited production period of three to four months would be required for beginning plant operations, for post-mine development and for employment training. During this period, the permanent work force would be increased to 235 employees. Shortly after the limited production period a total work force of 310 people would be reached and then continue for the life of the mine.

The plant would operate on a 7-day, 24-hour schedule. Employees would work a 40-hour work week, with the largest number working Monday through Friday during the day shift (A Shift). A skeleton crew would operate the plant on weekends. The following tabulation outlines the work force schedule:

Management	Shift A	Shift B	Shift C	Shift D	Total
Mine	4	3	1	2	10
Mill	7	2	2	2	13
Mechanical	7	3	3	2	15
Engineering	8				8
Accounting	9				9
Miscellaneous	3	2	1	1	7
Subtotal	38	10	7	7	62
Labor					
Mine	35	33	20	14	102
Mill	16	10	10	10	46
Shop	42	22	22	14	100
Subtotal	93	65	52	38	248
Total	131	75	59	45	310

d. Housing

A limited number of houses may be built by ASARCO for management employees. Housing would not be furnished for the remainder of the work force.

e. Wages

The initial hourly wage rates for employees are summarized in Appendix A. ASARCO would also provide employees with medical and dental plans, as well as vacation, retirement and accident benefits.

7. Mining Facilities and Equipment

a. Roads

(1) Access Road

The main access road to the mine-mill site would be approximately 6.8 miles in length and would, with the exception of a two mile section of new construction from Highway 202, utilize existing Forest Service roads (Figure I-2). The two miles of new road construction would include a bridge across Lake Creek. The planned use of existing Forest Service roads would require reconstruction to meet a higher standard because of increased use and safety factors.

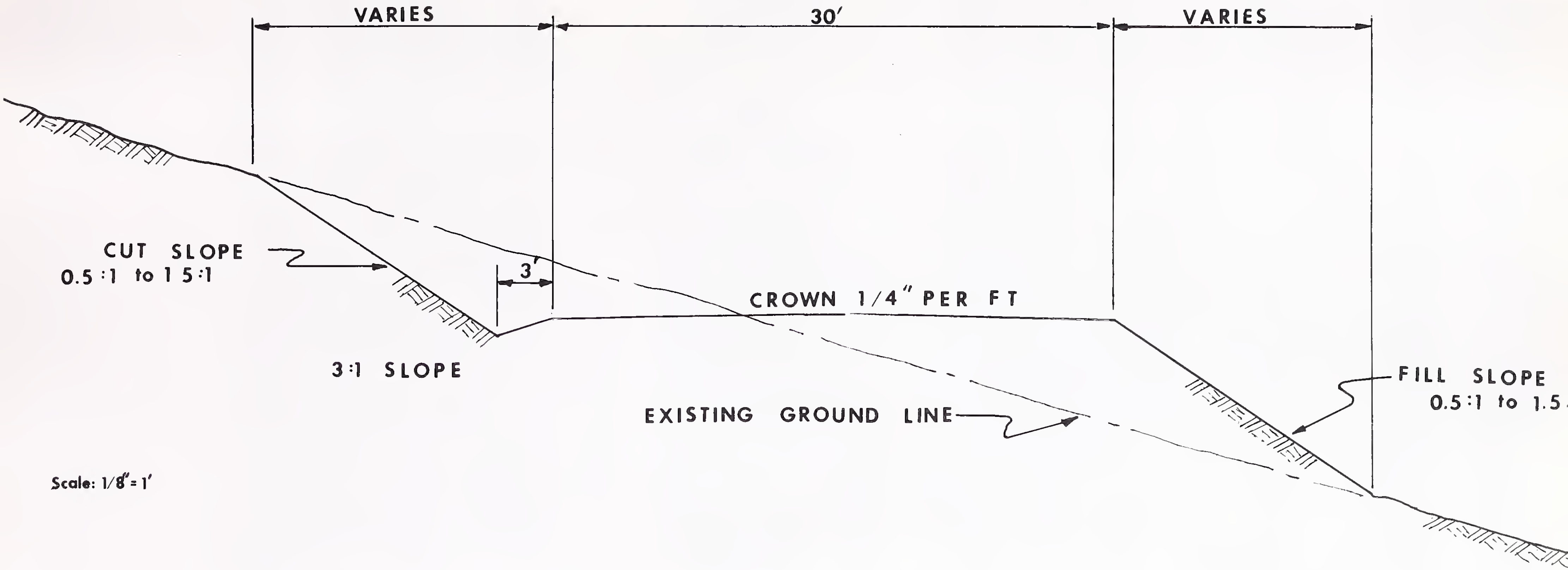
The two miles of new road construction have been designed by a private contractor at the request of ASARCO Inc. and involve the construction of a double lane bridge across Lake Creek. Design for the bridge has not been finalized, however, the possibility of installing a prestressed concrete structure that would span Lake Creek without in-creek disturbance is being considered. The design criteria for the new road construction is a double lane road with 11 foot traffic lanes and 3 foot shoulders. The surface would be an oil mat surface.

A design for the reconstruction of the existing Forest Service road from Lake Creek to the mine-mill surface is not complete. The design for this section of road would be a continuation of that used for the section of new construction as soil and topography would allow. A typical cross-section of the road is shown in Figure I-10.

It is anticipated that the design for the upgrading or reconstruction of the Forest Service road will involve:

1) replacement of the single lane bridge on upper Stanley Creek with a double lane bridge,

2) widening of the existing road to a double lane oil mat surface and



Scale: 1/8″= 1′

Figure I-10. ASARCO Troy Project typical access road cross-section.

3) reconstruction of several switch backs on Mt. Vernon to allow an 85 foot turning radius.

Final approval of the design for this section of road would rest with the Kootenai National Forest.

(2) Maintenance Roads

Low standard dirt roads exist from the mine-mill site to both the north and south adit and various exploration drill sites on Mt. Vernon. Some continued use of these roads would be expected for work and maintenance on the existing adits and proposed ventilation adits. Additional major roads on Mt. Vernon are not planned, although final location of the ventilation adits may require a small amount of additional low standard road construction. Use on these roads would be light, seasonal and restricted to only necessary use.

b. Railroad Facilities

Copper-silver concentrates produced at the mill site would be trucked from the mill to a rail car loading facility in Troy. An existing railroad siting located adjacent to the city jail is proposed to be upgraded with the construction of an adequate loading ramp facility. Concentrate production would necessitate the loading and transfer of 12 to 15 rail cars weekly. Either 100 or 80 ton solid bottom or dump bottom gondola rail cars would be used for concentrate haulage.

c. Utility System

Construction of approximately 18 miles of 115 Kv transmission line with a 24.9 Kv underbuild part of it's length would be required to provide power to the mine and mine related facilities. The proposed transmission line would be designed, constructed and owned by Northern Lights Inc., the existing major electrical power supplier to the Bull Lake Valley area. The transmission line would extend from the Bonneville Power Administration substation located approximately one mile east of Troy, Montana southerly along the Northern Lights Inc. existing 12.470 Kv distribution line right-of-way to the proposed mine access road intersection with Highway 202, and thence generally along the access road to the proposed mine site (Figure I-11).

Construction of the 115 Kv transmission line along the existing right-of-way would be accomplished by reconstructing the 12.470 Kv line

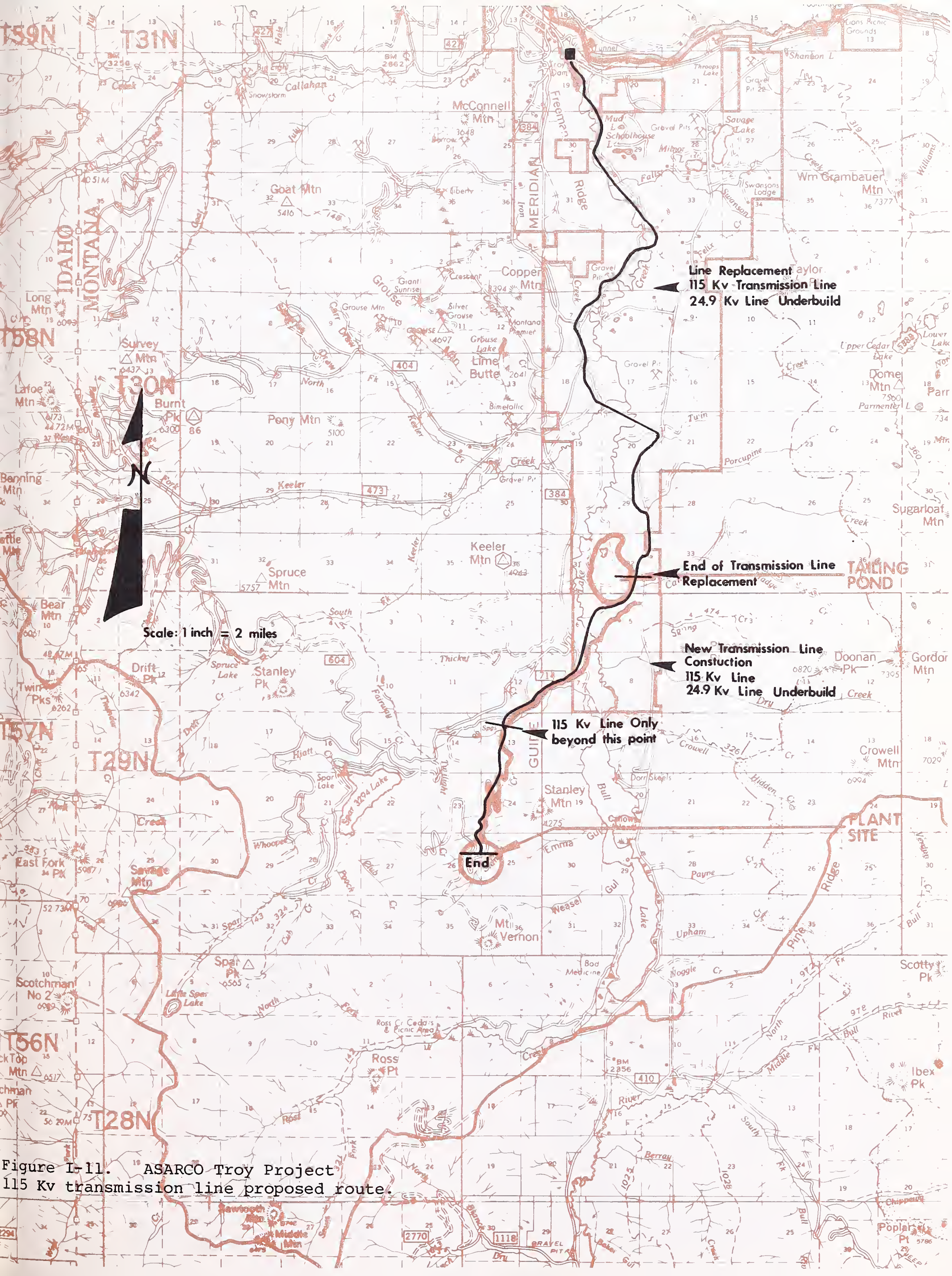


Figure I-11. ASARCO Troy Project
115 Kv transmission line proposed route.

with single pole structures wherever possible with the 115 Kv circuit located on top of the pole and the 24.9 Kv underbuild circuit located below to provide service to existing customers. The existing 12.470 Kv line would be upgraded to 24.9 Kv although at this time demand does not require the improvement. The 12.470 Kv line is old, however, and the ASARCO project would accelerate the future inevitable replacement of the distribution line to provide reliable service to existing Northern Lights Inc. customers.

Construction of a transformer-substation is proposed for the mine site (Figure I-7). The substation would convert the 115 Kv circuit to the voltage levels commonly used by the mine facilities. In addition to providing the correct voltage levels for facilities located at the mine-mill site, power would also have to be provided to the fresh water well pumps and facilities associated with the tailing impoundment. Several alternative methods of distributing power to these areas are being considered by Northern Lights Inc. Regardless of the method chosen, the route of the proposed transmission line would remain unchanged.

Additional information regarding the proposed transmission line can be found in Appendix B. Appendix B contains a copy of the application made by Northern Lights Inc. on December 30, 1977 to the Montana Department of Natural Resources and Conservation for a certificate of Environmental Compatability and Public Need for the proposed transmission line, as required by the Montana Major Facilities Act.

d. Utility Corridor

Pending additional engineering studies the exact location of the tailing pipeline, 115 Kv transmission line, and buried reclaim water pipeline will not be known. Rather, with the exception of Sections 24 and 25, T29N, R34W a 600 foot corridor paralleling the access road and using it as a centerline has been proposed by ASARCO as a corridor within which ultimately the two pipelines and transmission line would be located.

e. Main Adit

The main adit for the mine would consist of a 15 by 30 foot adit driven at ±13 percent grade from the plant site patio to the underground ore body (Figure I-12). The mine water sump system, primary ore crusher and ore transport system to the secondary crusher would be located in the main adit and in immediately adjacent excavated areas. The adit would be the primary entrance to the mine for all mining equipment and personnel.

Recent exploratory drilling by ASARCO at the originally proposed main adit location has shown bedrock to be considerably deeper than

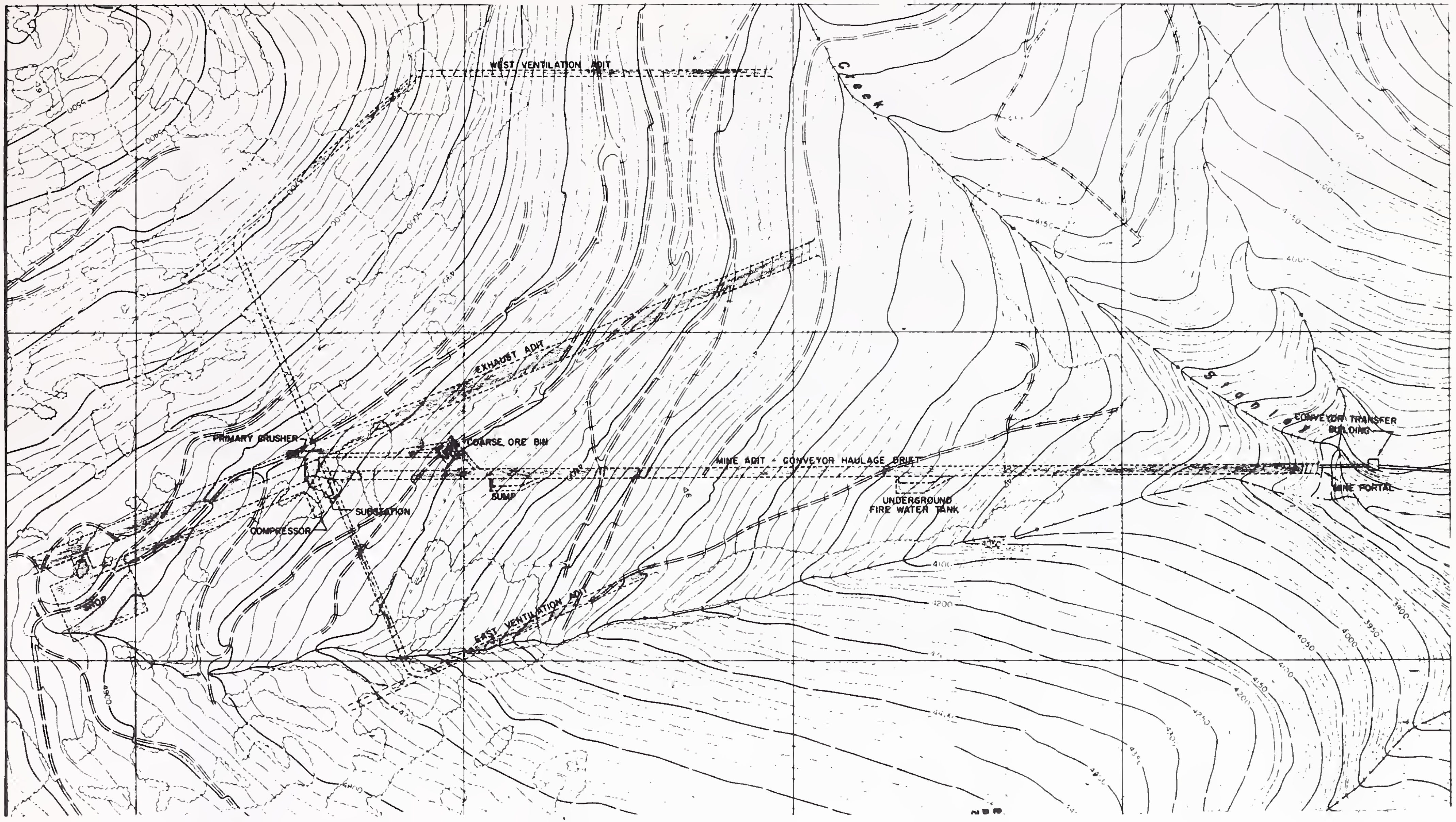


Figure I-12. ASARCO Troy Project conceptual underground development plan.

originally anticipated, making the cost of driving an adit (through unconsolidated material) prohibitive. As a result, ASARCO is considering a minimum of three other potential main adit locations corresponding to the locations identified on Figure I-13 and noted by ASARCO as follows (Bingham letter, January 3, 1978):

> *Alternative 1 is the adit location previously submitted, which corresponds with the plant site descriptions contained in our operating plan. Exploratory drilling this past summer has shown bedrock to be considerably deeper than anticipated and at this point, I believe this site will probably be abandoned.*
>
> *Alternative 2 is a possibility because bedrock appears relatively close to the surface east of the East Fork of Stanley Creek. This would eliminate the problem of trying to drift through glacial fill, but may lend itself to problems crossing the east fault which is the east boundary of the ore body.*
>
> *Alternative 3 is the most probable adit location at this point in time. It lends itself to the proposed plant site arrangement previously submitted and offers the environmental advantage that we will not disturb Stanley Creek.*
>
> *Until engineering has been completed and all the pros and cons evaluated, all these alternates, plus others, are possible.*
>
> *Alternative 4 is shown as a possibility because it involves relocation of the concentrator at the lower plant site. Although possible, this alternative is not very probable because of the large amount of underground drifting. Alternative 4 corresponds with the plant arrangement shown on the map.*

f. Underground Facilities

In addition to the primary crusher, course ore bin and ore conveyor, a compressor room, electrical switch gear room, possible maintenance shop and mine water sump would be located in the mine. A general arrangement is shown in Figure I-12. Approximately 200,000 tons of waste would be excavated for the facilities including the main adit. Waste material excavated would be used in the plant construction process.

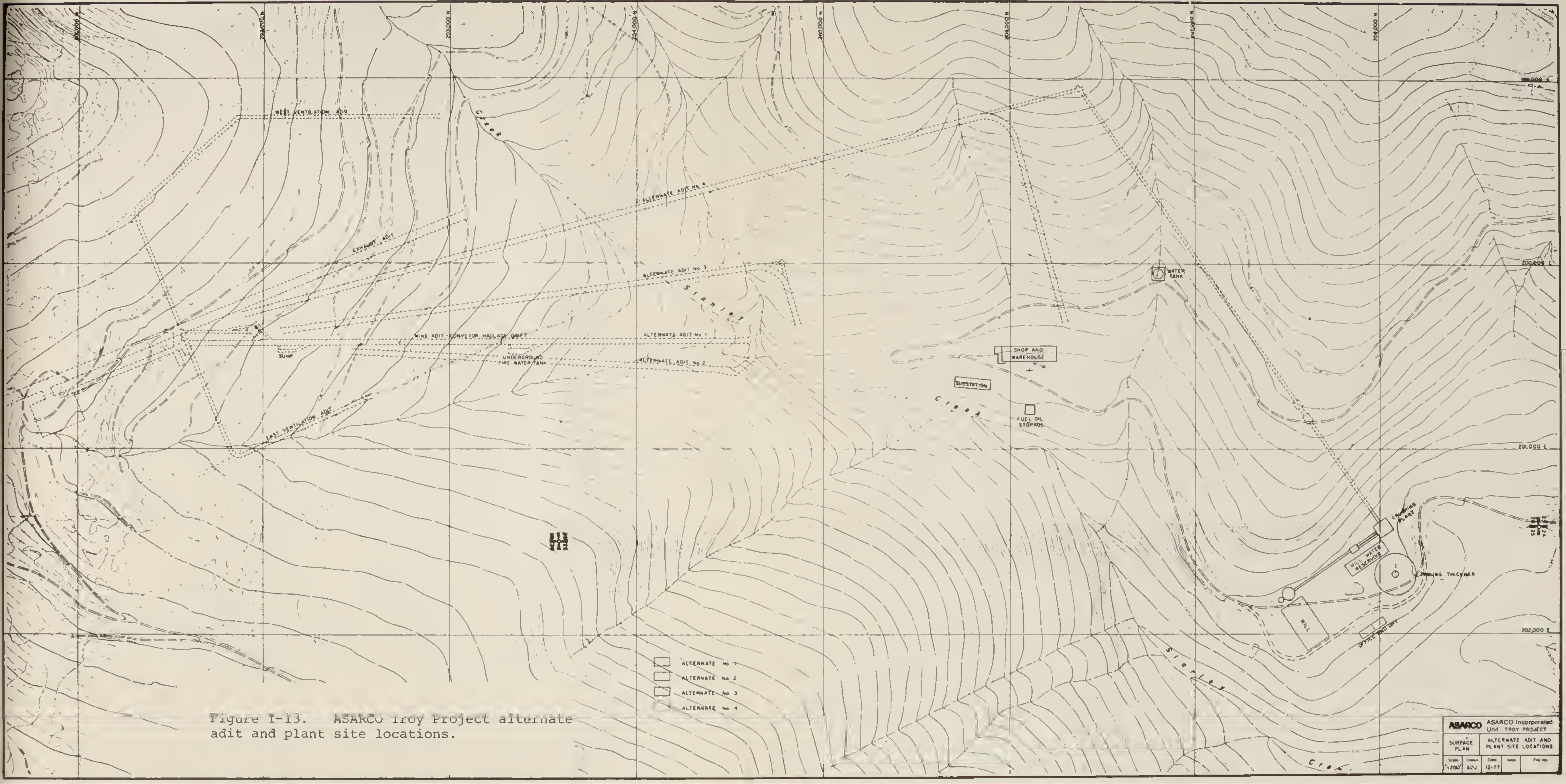


Figure I-13. ASARCO Troy Project alternate adit and plant site locations.

e. Mine Ventilation System

As discussed previously the mine ventilation system would involve three air intake ventilation adits (including the main adit) and one air discharge exhaust adit (Figure I-12). A 500 HP fan capable of moving 550,000 cubic feet per minute of air is presently planned for the exhaust adit. If a need to heat the intake air occurred during the winter months, the flow of air would be reversed and air intake occur through the exhaust adit and a heating system. Discharge of air would occur through the ventilation adits normally used for air intake.

h. Fire Prevention System

A six to eight inch main and hydrant system would be located around the perimeter of the plant site. Hydrants would be located and spaced according to the standards set by the National Fire Protective Association and the Montana Fire Code. The water supply for the hydrants would be obtained from a 500,000 gallon fire reserve water supply in the mill water tank and a rechargeable 250,000 gallon reserve at the mine sump. Fire buildings containing hoses and nozzles would be located beside hydrants while fire hoses on reels would be located inside selected building entrances. In addition, one mobile fire trailer would be maintained on the plant site. A fire fighting crew manned by employees trained in mine and surface fires would have quarterly fire drills and would be readily available with heavy equipment to aid in fighting forest fires.

i. General Plant and Facilities

The plant site would be located at the 3700 foot elevation on the north side of Mt. Vernon. Construction at this site would consist of a crusher building, mill and concentrator building, conveyor galleries, fuel and water storage tanks, substation and limited parking facilities.

Located at the 3500 foot elevation and a short distance from the plant site would be a 225 foot diameter tailing thickener, mill water reservoir, main office and shower-change rooms, scale, warehouse and maintenance shop, sewage treatment plant and parking for approximately 170 cars (Figure I-14).

A general arrangement of facilities proposed for the sites is shown in Figure I-7. The exact location of the plant buildings will not be known until final engineering studies for the project are complete. In particular, the route chosen for the tailing line will affect the tailing thickener location, which in turn would affect the position of the other buildings at the lower plant site. Final determination of the main adit location will influence the location of concentrator and crusher. Figure I-13 presents a possible rearrangement of plant facilities to accomodate the main adit location alternative #4 previously discussed.

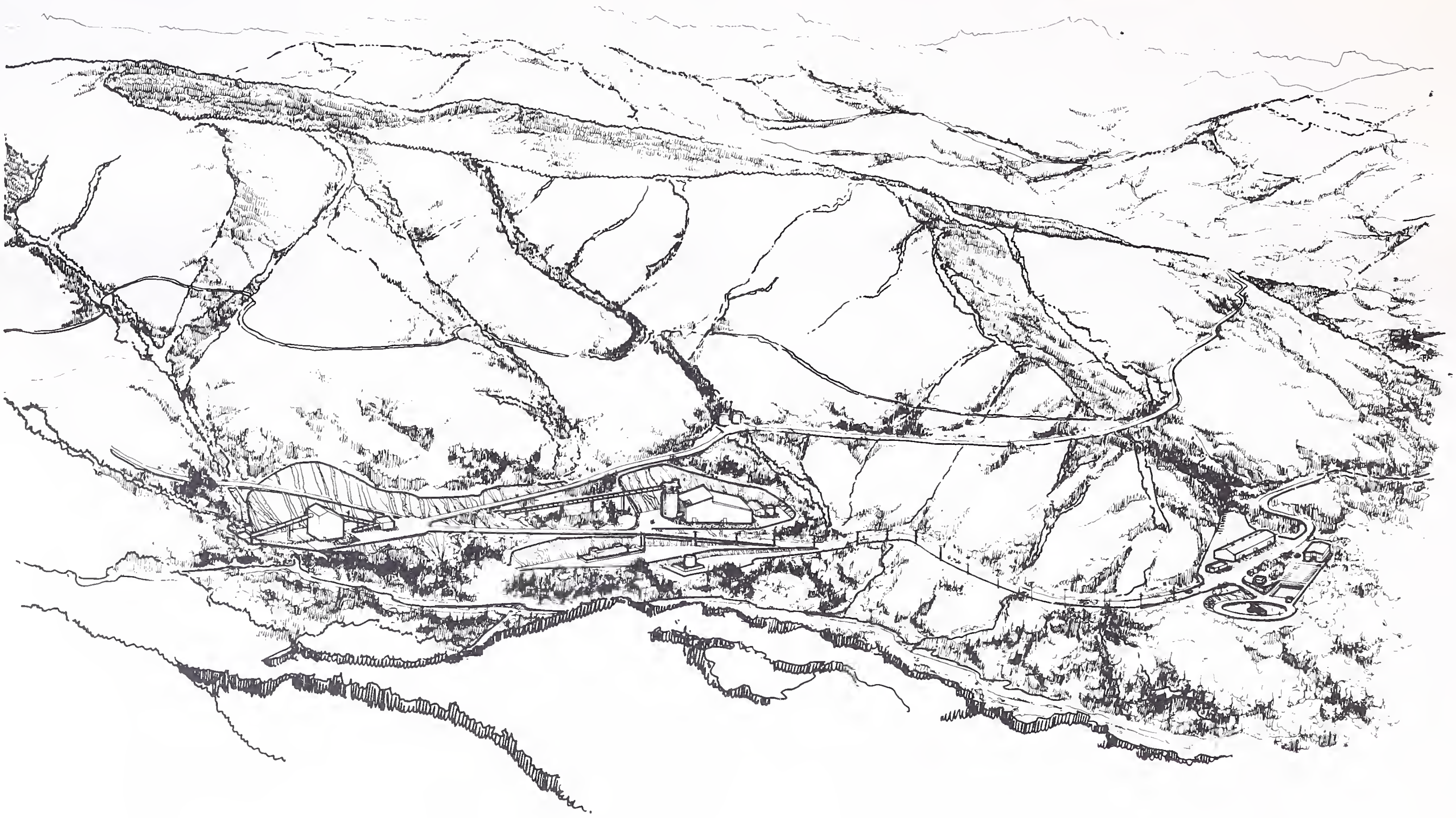


Figure I-14. ASARCO Troy Project artist conception of plant site.

In addition, ASARCO is considering the possibility of relocating a portion of the surface plant underground. If feasible, this would involve relocating the secondary crusher and concentrator underground as shown in Figure I-15. The milling and concentration process would remain the same.

(1) Secondary Crusher and Transfer Building

A conveyor system would transport ore from the primary crusher within the mine to the crusher and transfer building adjacent to the main adit portal. Ore would be deposited in a surge bin for discharge into a continuous circuit of sizing screens and crushers (Figure I-8). Following reduction to a minus three-quarters inch material, the ore would be transported by conveyor galleries to the fine ore storage bin in the mill and concentrator building.

(2) Mill and Concentrator Building

Within the mill and concentrator building the ore would be further reduced in size and would proceed through the flotation and concentration process. Waste from this process, called tailing, would proceed in a slurry form by pipeline from the mill and concentrator building to the tailing thickener.

(3) Tailing Thickener

A 225 foot diameter tailing thickener located at the lower plant site would receive tailing from the mill and concentrator building through an 18 inch diameter transite pipeline. Tailing would enter the thickener where the solids would be allowed to settle. Excess water would separate from the tailing and be decanted into the mill water reservoir for reuse at the mill. Thickened tailing would be raked to the center and exit from the lower portion of the thickener and enter the tailing pipeline for transfer to the tailing impoundment approximately 6½ miles distant. Location of the tailing thickener would depend on the final route chosen for the section of tailing pipeline located below the thickener.

(4) Process and Fire Water Tank

A one million gallon mill water tank would be located near the mill and concentrator building for gravity distribution of water to the concentrator, crusher, shop, etc. Water for the tank would be piped from the mill water reservoir in a buried 16 inch diameter steel pipeline and would represent water received from the reclaim waterline and the tailing thickener. In addition, excess mine water would be pumped to the tank from the mine portal in a buried eight inch diameter steel line. The water would not be used for domestic purposes. Approximately one-half of the tank's capacity would be reserved for fire fighting.

(5) Potable Water Supply

Located adjacent to the mill and fire water tank would be a 50,000 gallon storage tank for the potable water supply. Water would be obtained from a parallel submerged intake system along the upper fork of Stanley Creek above the main portal. A perforated four foot diameter pipe would be buried in the gravel adjacent to the creek and then packed with sand in order to act as a collection sump. On the down gradient end of the perforated pipe a concrete stand pipe would protrude to the surface through which collected water would be pumped to the tank.

(6) Warehouse and Maintenance Shop

Located near the main office site would be both a warehouse for the storage of equipment used in the mining and milling process and a maintenance shop for equipment repair.

(7) Office and Change House

Located at the 3500 foot elevation would be a main office and shower-change house for the mine employees. A parking lot for approximately 170 cars would be constructed adjacent to the main office.

(8) Sewage Treatment Plant

Effluent from office sanitary facilities and from shower stalls in changerooms would be collected and treatment provided at a secondary sewage treatment facility utilizing an extended aeration mode of activated sludge process. The facility, located at the lower plant site, would be designed to treat 15,000 gallons per day of domestic sanitary sewage and would receive effluent averaging 25 gallons per minute (gpm). The sewage treatment system would be an above ground installation and utilize completely integral tankage comprised of a sewage tank, sludge holding

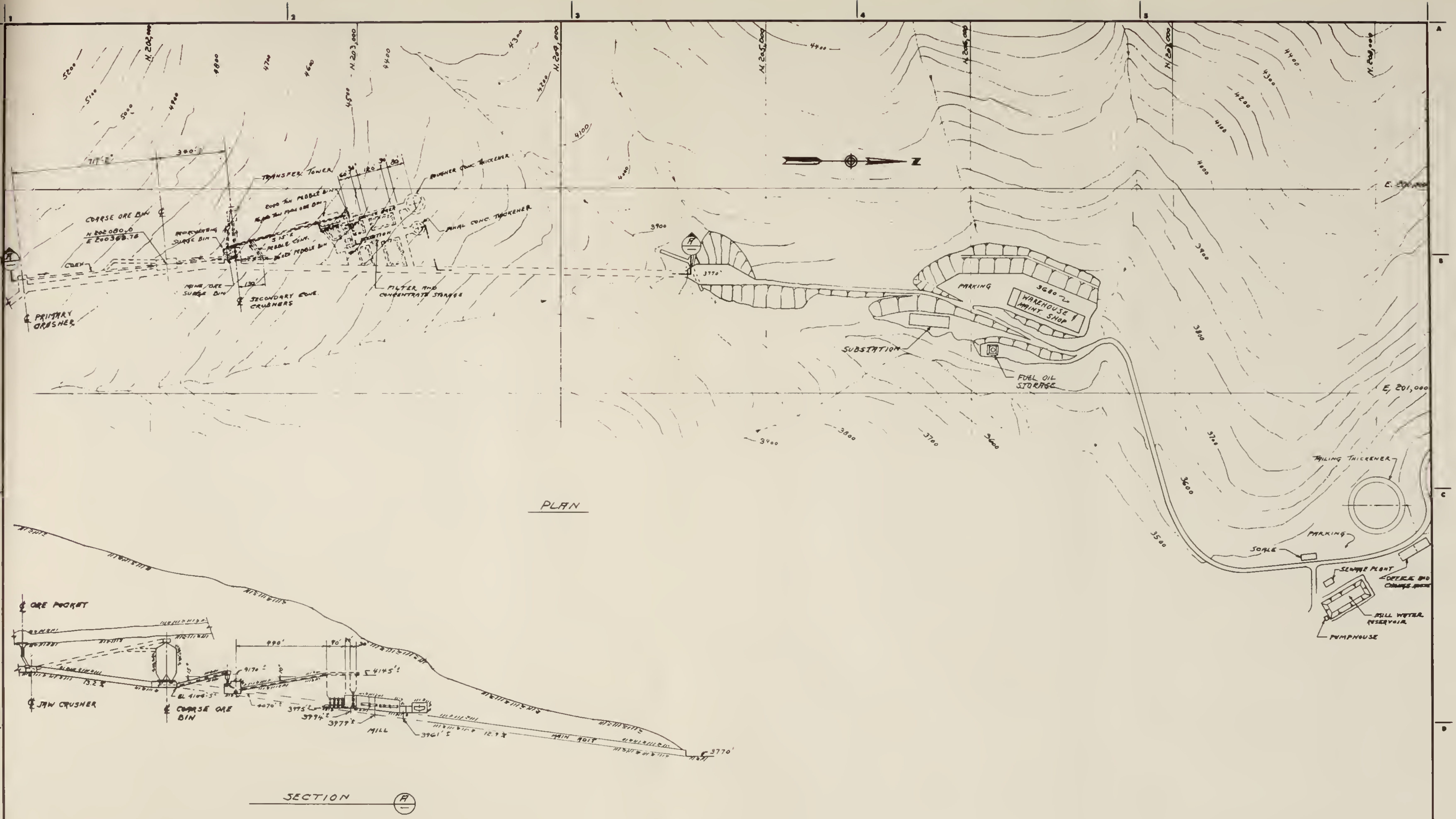


Figure I-15. ASARCO Troy Project underground crushing and milling alternate.

tanks, aeration tank with clarifier and a chlorine contact tank. Following treatment, the facility would discharge the effluent into the tailing thickener for transport to the tailing impoundment. Water used for domestic purposes would thus enter the pond and be available for reclaimed use within the milling and concentration process.

(9) Mill Water Reservoir

A 1.87 million gallon mill water reservoir (100 feet by 250 feet by 10 feet) located adjacent to the tailing thickener and constructed similar to the mill water sump would be constructed prior to development of the main adit and mine water sumps. The mine water discharge would be piped from a small holding sump outside the portal to the mill reservoir if volumes of water encountered in the adit so required. Provision would be made to discharge a clear overflow from the reservoir into the drainage immediately north of the plant site should the reservoir be used in this manner during the mine development.

Following development of the mine water sump and the mill operations, the reservoir would receive water reclaimed from the tailing slurry at the tailing thickener and water from the reclaim water line. Water would be pumped in a 16 inch diameter buried steel pipeline from the reservoir to the process and fire water tank for the necessary gravity distribution to the mill facilities.

(10) Scale

A heavy duty scale would be located near the warehouse and maintenance shop at the lower plant site. In addition to the weighing of concentrate haul trucks, all other vehicles would be weighed for security reasons upon entering and leaving the mine and plant site.

j. Tailing Slurry Pipeline

A tailing slurry from the concentrator facilities would flow approximately 2,500 feet by gravity in an 18 inch diameter transite pipeline to the 225 foot diameter tailing thickener located at the lower plant site. The first 200 feet of pipe exiting the concentrator would be buried, while the remainder would be located above ground. Gradient of the line from the concentrator to the thickener would be maintained in sections at near three percent for transport of the unthickened slurry. At the downstream end of each section a vertical drop-inlet cylindrical concrete stilling well (drop-box) would be located into which the slurry would pour (Figure I-16). An outlet at the bottom would drain the slurry into the next section of pipeline. In this manner the slurry would be stepped to the tailing thickener and thence down the side of the mountain to the valley of Stanley Creek and to the impoundment area.

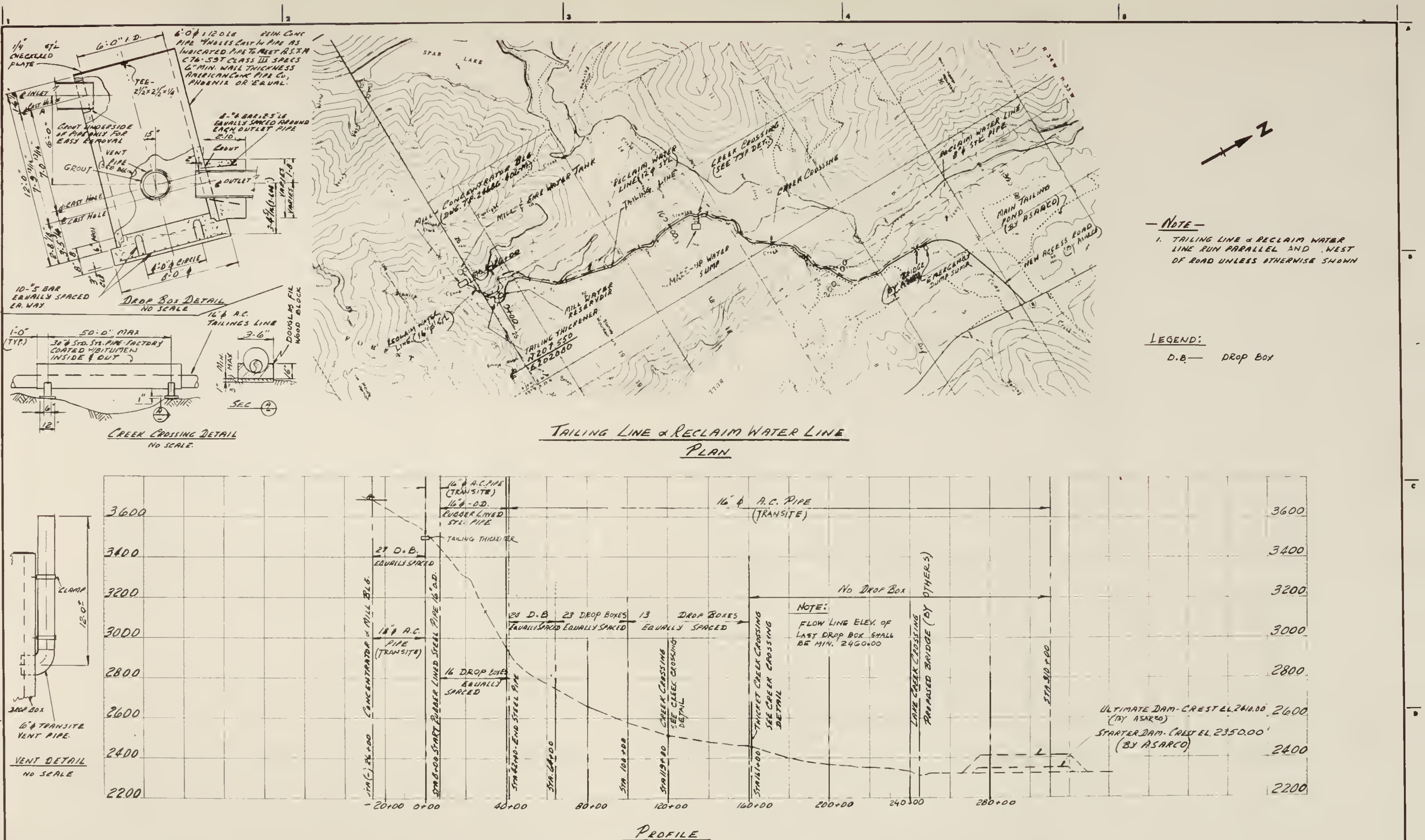
If the pipeline were to clog at any point, tailing slurry could rise in a stilling well and spill over the top. If a spill were to occur, the impounded tailings would be removed and transported to the tailing impoundment area. Approximately 100 of the stilling wells would be required for the 6½ miles of pipeline.

Figure I-17 shows three potential routes currently being considered by ASARCO for the section of pipeline located immediately downstream from the tailing thickener. A preferred route for this section of pipeline has not been chosen by ASARCO pending additional engineering considerations of the steep topography present. Along this section of pipeline the steepness of decent grade would necessitate the use of 16 inch diameter rubber-lined steel pipe which is more abrasive resistant than transite pipe. In addition to the possible use of the rubber-lined pipe, other types of abrasive resistant pipeline are being investigated by ASARCO. Visual appearance along this section of pipeline would, however, be identical to the remainder of the pipeline.

The gradient of the pipeline for the remainder of it's route downstream from the steep topography in Sections 24 and 25 T29N, R34W, would be maintained at approximately three-quarter percent grade to reduce tailing velocity and consequent erosion of the transite pipe.

The tailing line would rest on wood block supports located on compacted fill as shown in Figure I-16. With the exception of the section of tailing line located immediately downstream from the thickener on steep topography, the pipeline would be located within a 600 foot utility corridor and generally adjacent to the access road (Figure I-2). Stream crossings by the pipeline would involve a dual line system. In order to prevent discharge into a water course in the event of a line failure, the 16 inch diameter pipeline would be enclosed within a 30 inch steel pipe.

A flow sensor designed by the Process Control Division of Honeywell International at the request of ASARCO is presently being considered as a simple, reliable method for sensing breaks or blockage in the tailing slurry pipeline. The sensor measures the difference in weight between an empty and a full or partially full length of pipeline. Properly interpreted, the measurement could be used to detect interruptions in tailing flow and indicate broken or plugged sections of the pipeline. The system consists of a sealed hose filled with silicon fluid, a pressure sensor/transmitter, a millimeter and a power supply (120 vac/24 vdc). In operation, a length of tailing pipe (preferably the length immediately upstream of a drop box) would rest on the hose which is connected to the pressure sensor/transmitter. The unit would generate a 24 volt, 4 to 20 milliamp signal proportional to the weight of the pipe and therefore, proportional to the weight of the slurry in the pipe. The signal indicating the presence of the slurry in the pipeline would be transmitted to a millimeter located in the mill. An alarm indicating a break or plug



1/4" STL CHECKERED PLATE
6'-0" I.D.
6'-0"φ x 12'-0 LG REIN. CONC PIPE 4 HOLES CAST IN PIPE AS INDICATED. PIPE TO MEET A.S.T.M C76-59T CLASS III SPECS 6" MIN. WALL THICKNESS AMERICAN CONC PIPE CO, PHOENIX OR EQUAL.
TEE- 2½"x2½"x¼
INLET
CAST HOLE
GROUT UNDERSIDE OF PIPE ONLY FOR EASY REMOVAL
15°
VENT PIPE (SEE DET.)
GROUT
8-"6 BARS x 2.5' LG EQUALLY SPACED AROUND EACH OUTLET PIPE
2'-10"
OUTLET
VARIES
1'-0"
3'-4 5/16"
12'-0"
7'-9 13/16"
7'-0"
6'-0"
CAST HOLE
CAST HOLE
4'-0"φ CIRCLE
8'-0"φ
10-#5 BAR EQUALLY SPACED EA. WAY.
DROP BOX DETAIL
NO SCALE
16"φ A.C. TAILINGS LINE
1'-0" (TYP.)
50'-0" MAX
30"φ STD. STL. PIPE - FACTORY COATED W/BITUMEN INSIDE & OUT
3'-6"
DOUGLAS FIR WOOD BLOCK
MIN. MAX
6"
12"
SEC A
CREEK CROSSING DETAIL
NO SCALE
CLAMP
12'-0"±
DROP BOX
6"φ TRANSITE VENT PIPE.
VENT DETAIL
NO SCALE
SPAR LAKE
MILL CONCENTRATOR BLG (DWG. TP. 24...)
MILL & FIRE WATER TANK
RECLAIM WATER LINE (12"φ STL)
TAILING LINE
CREEK CROSSING (SEE TYP. DET.)
CREEK CROSSING
RECLAIM WATER LINE 8"φ STL PIPE
MAIN TAILING POND (BY ASARCO)
NEW ACCESS ROAD (BY ASARCO)
BRIDGE (BY ASARCO)
EMERGENCY DUMP SUMP
MAKE-UP WATER SUMP
MILL WATER RESERVOIR
TAILING THICKENER N207 550 E202080
RECLAIM WATER LINE (16"φ STL)
Z
- NOTE -
1. TAILING LINE & RECLAIM WATER LINE RUN PARALLEL AND WEST OF ROAD UNLESS OTHERWISE SHOWN
LEGEND:
D.B. — DROP BOX
TAILING LINE & RECLAIM WATER LINE
PLAN
3600
3400
3200
3000
2800
2600
2400
2200
16"φ A.C. PIPE (TRANSITE)
16"φ - O.D. RUBBER LINED STL. PIPE
TAILING THICKENER
16"φ A.C. PIPE (TRANSITE)
27 D.B. EQUALLY SPACED
18"φ A.C. PIPE (TRANSITE)
16 DROP BOXES EQUALLY SPACED
20 D.B EQUALLY SPACED
23 DROP BOXES EQUALLY SPACED
13 DROP BOXES EQUALLY SPACED
NO DROP BOX
NOTE: FLOW LINE ELEV. OF LAST DROP BOX SHALL BE MIN. 2460.00
STA(-) 26+00 CONCENTRATOR & MILL BLG.
STA 6+00 START RUBBER LINED STEEL PIPE 16" O.D.
STA 42+00 - END STEEL PIPE
STA. 64+00
STA. 100+00
STA 119+00 CREEK CROSSING SEE CREEK CROSSING DETAIL
STA 161+00 THICKET CREEK CROSSING SEE CREEK CROSSING DETAIL
LAKE CREEK CROSSING
PROPOSED BRIDGE (BY OTHERS)
STA 310+00
ULTIMATE DAM-CREST EL 2610.00' (BY ASARCO)
STARTER DAM-CREST EL. 2350.00' (BY ASARCO)
-20+00
0+00
40+00
80+00
120+00
160+00
200+00
240+00
280+00
PROFILE

Figure I-16. ASARCO Troy Project tailing
and reclaim water line plan and profile.

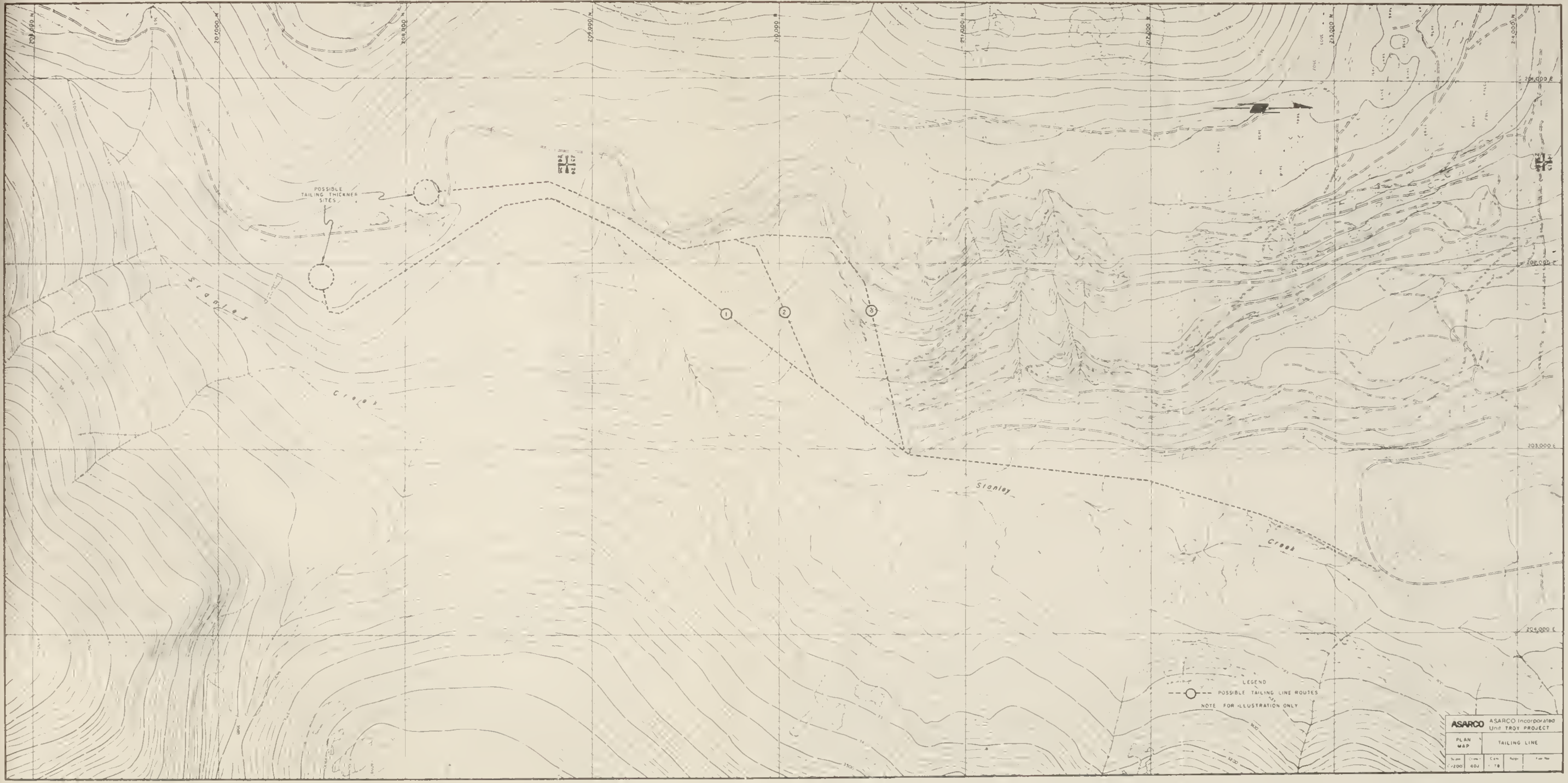


Figure I-17. ASARCO Troy Project alternate tailing line routes.

upstream from the sensor would sound if a low flow condition were indicated. If the alarm were to sound, the mill operator would contain the flow of tailing in the tailing thickener until the line were repaired or the mill shut down. Several of the pressure sensors would be located along the length of the tailing pipeline.

k. Emergency Dump Sump

An emergency dump sump would be located at the lowest elevational point of the tailing slurry pipeline (Figure I-2). The sump would receive tailing slurry from the pipeline should an unexpected shutdown of the line occur, as well as during scheduled shutdowns. The 250 by 100 foot sump would be located above ground, constructed of compacted fill and have a capacity of 800,000 gallons. Tailing deposited in the sump would be removed and trucked to the tailing pond for disposal.

l. Tailing Impoundment

(1) Foundation Preparation

Topsoil would be stripped from beneath the starter dam foundation as well as from a large portion of the initial impoundment area and then stockpiled at selected locations nearby (Figure I-18). The foundation area beneath the starter dam would be graded and compacted to provide a relatively smooth and firm surface for construction of the starter dam embankment and drain system.

(2) Starter Dam Embankment

The purpose of the starter dam would be twofold: 1) to provide for initial deposition of tailing and 2) to provide a stable toe for the tailing impoundment area. Maximum crest elevation of the starter dam would be approximately 30 feet, with 3 to 1 sideslopes, a 20 foot crest width and a 10 foot deep cutoff trench as shown in Figure I-20. Starter dam embankment construction would utilize on-site soils. Processed on-site sands and gravels would be used for development of the drain system.

Initially, borrow areas near the starter dam and a small system of starter dikes would be developed to direct tailing water to the decant system in a pond located away from the starter dam embankment.

A drain system would be comprised of a cycloned sand drain located against the upstream face. This would be connected to a pipe drain system along the upstream toe with outlet pipes beneath the embankment. In addition with a sand and gravel drain in the downstream toe would be utilized. The pipe drain system would consist of a six inch perforated steel or plastic pipe located along the upstream toe of the starter dam with outlets to the downstream toe at 500 foot intervals. The pipe would be installed in trenches in the natural soil and be backfilled with well graded, free-draining sands and gravels to the surface of the natural ground as shown in Figure I-19.

Construction of the outlet drains would be similar to that of the lateral drains; both would utilize the same trench conditions and backfill material. The outlet drains, however, would use large diameter perforated pipes. The pipe drain system would be connected to a "wedge" of cycloned clean tailing sand placed against the upstream face.

A small number of cyclones mounted on a movable base would be used to construct the sand "wedges". The downstream toe drain would be constructed with well graded, clean, free-draining sand and gravel, processed from on-site sources. A shallow ditch would be constructed at the downstream toe of the starter dam to collect the seepage from the underdrain system. The seepage would be transferred to the reclaim water pond by gravity and pumps.

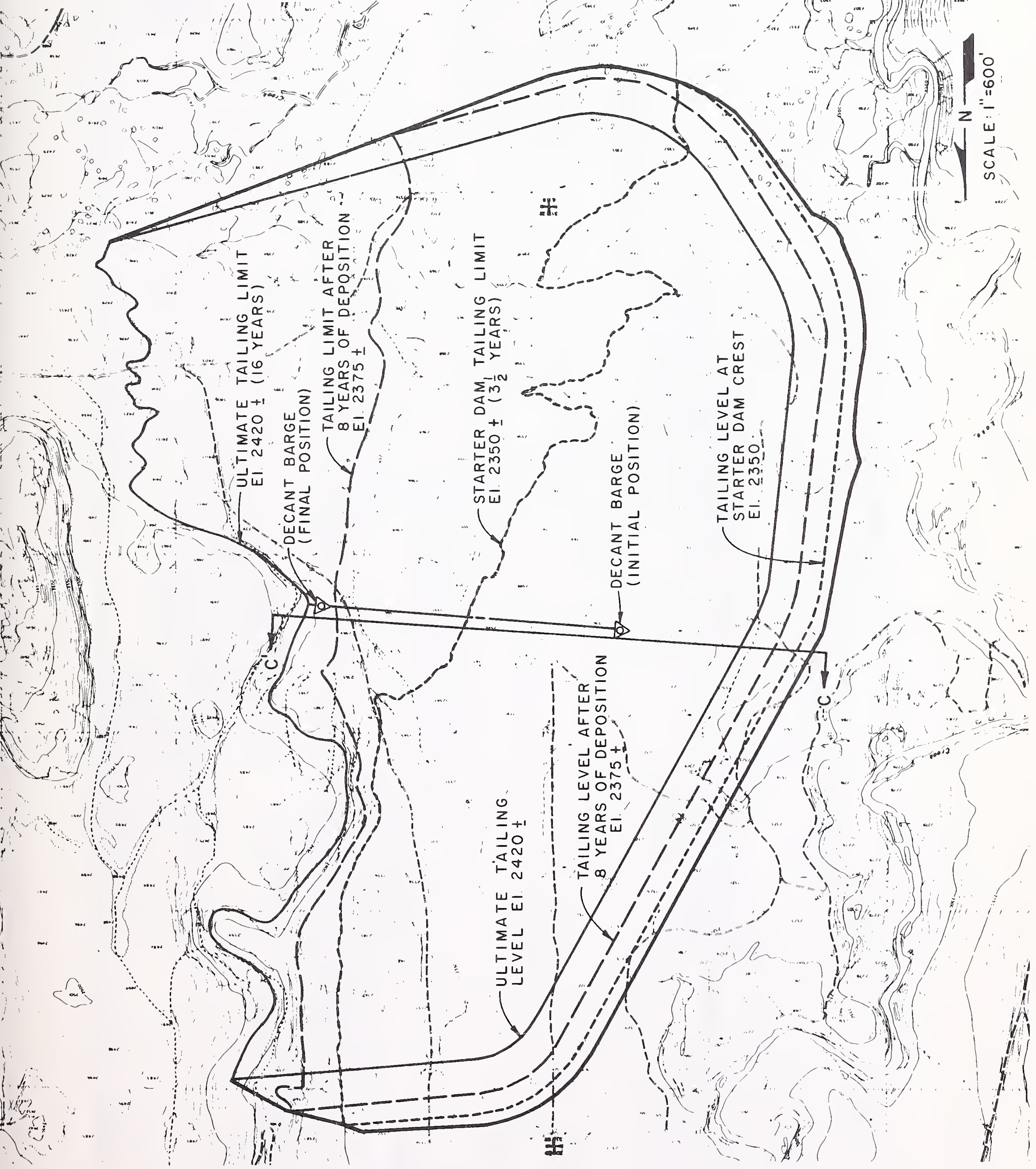
The crest of the starter dam would meet the ground surface at a point on the dam abutments because of the increasing ground elevation. At these locations small starter dikes would be needed to support the tailing discharge system and to maintain flow to the decant system. The small dikes (five feet high) would be constructed from natural soils adjacent to the dikes placed in thin lifts and compacted to moderate densities.

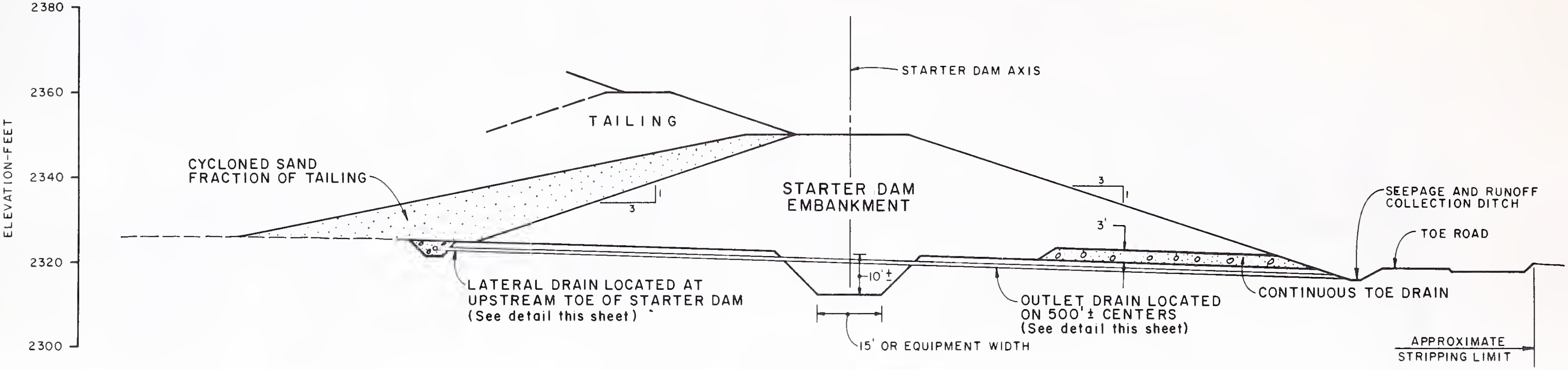
The anticipated levels and limits of tailing in the impoundment area at 1) initial startup, 2) the crest level of the starter dam, 3) after eight years of operation and 4) at the ultimate level are shown in Figures I-20 and I-21.

(3) Tailing Distribution System

A distribution system consisting of a header pipe with spigots would be used for discharging the tailing from the dam crest. Initial designs have assumed an 18 inch diameter header pipe and 4 inch diameter spigots spaced at ±24 foot centers. Experimentation would be required in order to determine the optimum spacing for the spigots so that a good distribution of tailing could be obtained. The tailing impoundment area would be raised above the starter dam and starter dikes using a series of small tailing dikes pushed up from the interior of the impoundment area.

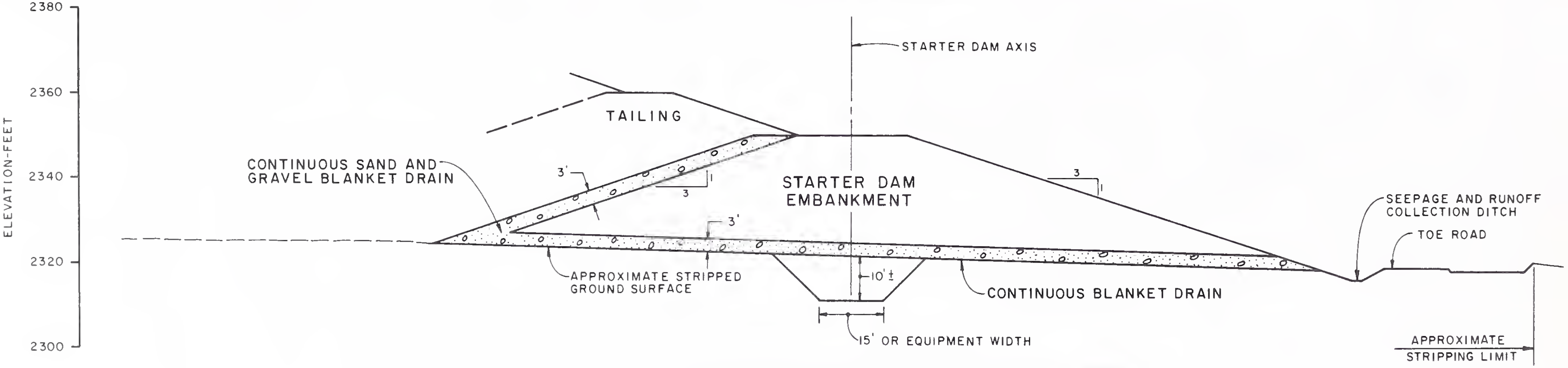
Tailing would not be deposited along the entire length of the starter dam at one time. Deposition sequences would be controlled to allow dike building operations to occur at the same time as tailing deposition. As the impoundment area rises additional header pipe and


ULTIMATE TAILING LIMIT
El 2420 ± (16 YEARS)
TAILING LIMIT AFTER
8 YEARS OF DEPOSITION
El. 2375 ±
DECANT BARGE
(FINAL POSITION)
STARTER DAM TAILING LIMIT
El. 2350 ± (3½ YEARS)
DECANT BARGE
(INITIAL POSITION)
TAILING LEVEL AT
STARTER DAM CREST
El. 2350
ULTIMATE TAILING
LEVEL El 2420 ±
TAILING LEVEL AFTER
8 YEARS OF DEPOSITION
El. 2375 ±
C
C
N
SCALE: 1"=600'


ELEVATION-FEET
2380
2360
2340
2320
2300
STARTER DAM AXIS
TAILING
CYCLONED SAND FRACTION OF TAILING
STARTER DAM EMBANKMENT
3
1
3'
SEEPAGE AND RUNOFF COLLECTION DITCH
TOE ROAD
10' ±
LATERAL DRAIN LOCATED AT UPSTREAM TOE OF STARTER DAM (See detail this sheet)
OUTLET DRAIN LOCATED ON 500' ± CENTERS (See detail this sheet)
CONTINUOUS TOE DRAIN
15' OR EQUIPMENT WIDTH
APPROXIMATE STRIPPING LIMIT

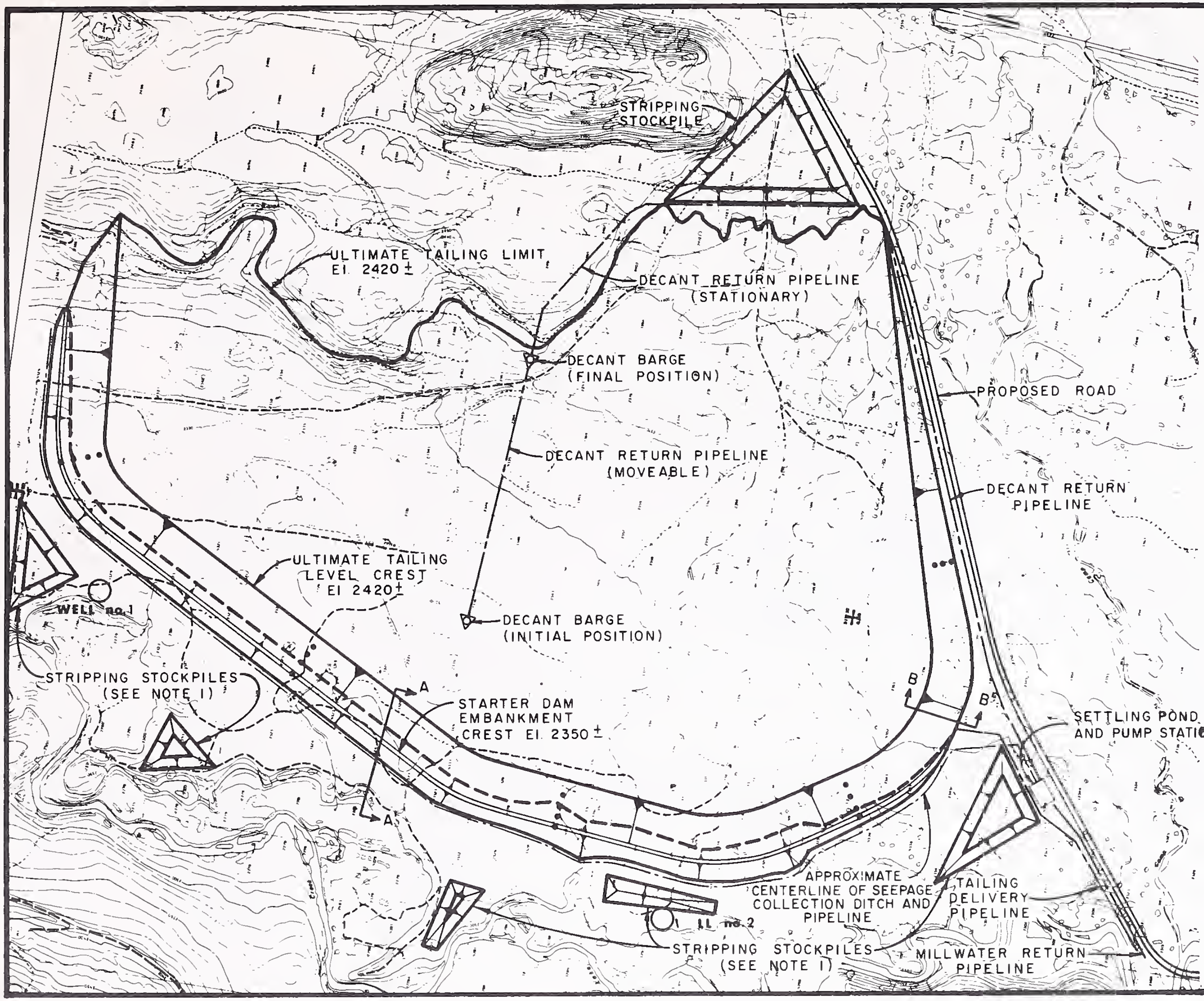
RECOMMENDED PIPE DRAIN SYSTEM

SCALE 1" = 20'



ALTERNATE GRAVEL BLANKET DRAIN SYSTEM

SCALE: 1" = 20'



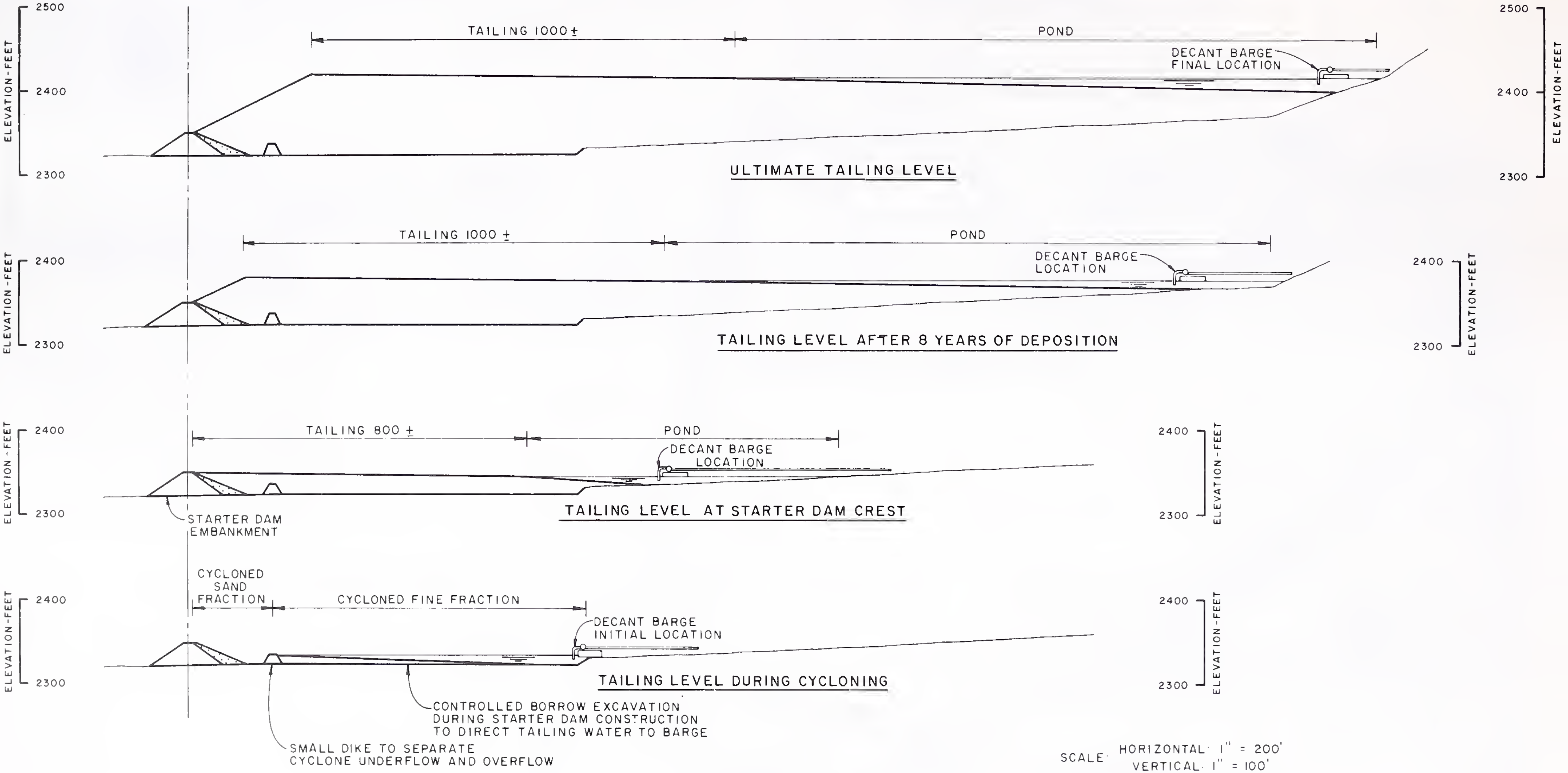
LEGEND

•	CONCEPTUAL LOCATION OF PIEZOMETER GROUP FOR INSTRUMENTED STUDY SECTION
⊥	EMBANKMENT SLOPE (DOWNSLOPE ↓)

NOTES:

1. STRIPPING STOCKPILES MAY BE USED WITH EITHER THE RECOMMENDED OR ALTERNATE STARTER DAM LOCATION, AND THE BARGE OR GRAVITY DECANT.
2. THE BARGE DECANT MAY BE USED WITH EITHER THE RECOMMENDED OR ALTERNATE STARTER DAM LOCATION.
3. LINES AND ELEVATIONS ON THIS DRAWING ARE CONCEPTUAL AND MAY CHANGE DURING FINAL DESIGNS.

FIG. 4



ELEVATION-FEET
2300
2400
2500
TAILING 1000±
POND
DECANT BARGE FINAL LOCATION
ULTIMATE TAILING LEVEL
TAILING 1000 ±
POND
DECANT BARGE LOCATION
TAILING LEVEL AFTER 8 YEARS OF DEPOSITION
TAILING 800 ±
POND
DECANT BARGE LOCATION
STARTER DAM EMBANKMENT
TAILING LEVEL AT STARTER DAM CREST
CYCLONED SAND FRACTION
CYCLONED FINE FRACTION
DECANT BARGE INITIAL LOCATION
TAILING LEVEL DURING CYCLONING
CONTROLLED BORROW EXCAVATION DURING STARTER DAM CONSTRUCTION TO DIRECT TAILING WATER TO BARGE
SMALL DIKE TO SEPARATE CYCLONE UNDERFLOW AND OVERFLOW
SCALE: HORIZONTAL: 1" = 200'
VERTICAL: 1" = 100'

SECTION C-C'

spigots would be added; this would result because the disposal system would be lengthened.

The disposal system would operate on a year-round basis. Deposition in the above-freezing portion of the year would occur as previously discussed with a header pipe and spigot discharge building up a sand beach along the crest. Deposition during the winter months may occur through a single pipe discharging into the interior of the area, the result of which would be the raising of the interior.

m. Tailing and Pond Decant System

A barge-mounted intake pump with an aboveground piping system would be used to pump water from the surface of the tailing pond to a settling and reclaim water pond. In order to assure water levels necessary for the proper function of the barge system, the barge would be moved progressively towards the interior of the impoundment area, similar to the sequence shown on Figures I-20 and I-21.

n. Reclaim Water Pond

A settling pond and pumps used to return decanted water to the mill would be located near the tailing impoundment, as shown in Figure I-18. The settling pond would be used to provide a more stable water supply to the pumps (known as surge capacity) and to reduce the amount of sedimented and floating debris entering the pumps. The pond would be approximately 250 feet long, 100 feet wide and 4.5 feet deep, with a capacity of 800,000 gallons. The pond would be constructed by excavating the interior and placing a compacted fill dike around the exterior. Current designs would utilize a pond lining constructed of a mixture of Bentonite and natural materials placed and compacted to a depth of about three feet on the botom and sides of the pond in order to reduce seepage. Pond designs would include a trash separator at the reclaim water pipeline intake.

Two 200 horsepower (hp) reclaim water pumps having a combined operating maximum of approximately 1500 gpm would be located in a pump station on the dike around the settling pond. It is anticipated that only one pump would operate during normal operating conditions, with the second pump serving as a standby. The pumps would have an automatic float system to consider mill requirements and settling pond levels. The pumps would be housed in a weather-tight metal building.

o. Reclaim Water Pipeline

Water pumped from the reclaim water pond to the mill water sump, and thence to the mill water reservoir and mill and fire water tank, would flow through a buried pipeline located adjacent to the tailing pipeline. An eight inch diameter steel pipeline would transport the reclaim water from the reclaim pond to the mill water sump, where it would enter a 12 inch diameter steel pipeline for transfer to the mill water reservoir. A 16 inch diameter steel pipeline would then transport the water to the mill and fire water tank. The pipeline would cross major streams and tributaries by attachment to the road bridges with hanger supports. The reclaim pipeline would be buried when crossing other waterways.

p. Stanley Creek Well Field

Two deep-water wells would be located in the northeast quarter of Section 13, T29N, R34W, about 2½ miles north of the plant site; these would be equipped with 75 hp, 1,750 gpm deep well pumps, and provide makeup water for the milling system during periods when the volume of reclaimed water is inadequate. Planned operating maximum for the wells would be 1,461 gpm while the designed maximum would be 1,700 gpm. During the first months following start-up and until adequate water is available for decant from the tailing impoundment, the fresh water wells would operate at the maximum 1,461 gpm flow. After reclaim water becomes available from the tailing pond, required well flow could be substantially reduced.

q. Mill Water Sump

Adjacent to the fresh water wells, the reclaim water and fresh water would be combined in an 800,000 gallon reservoir constructed similar to the reclaim water pond. The reservoir would provide surge capacity for pumping operations to the mill water reservoir at the plant site.

r. Monitoring Wells

The location of two test wells drilled by ASARCO in July, 1976 are shown in Figure I-18. Well No. 1 is located at the northwest corner of the proposed tailing impoundment site. Well No. 2 is located along the west edge of the proposed tailing impoundment site approximately 4,000 feet south and slightly west of Well No. 1. A driller's log of the materials encountered when drilling and a description prepared from the samples of drill cuttings are presented in Appendix C.

Three water samples were collected in July 1976 from the monitor wells at times of completion, two from Well No. 1 and one from Well No. 2. Results of the chemical analysis of these samples are also presented in Appendix C.

Scheduled monitoring of the wells would continue throughout the life of the project.

s. Fuel and Explosive Storage

Diesel fuel oil would be supplied to the plant and mine with a tank truck and stored in a 450,000 gallon above-ground storage tank located near the mill and concentrator site (Figure I-7). Consumption of the diesel fuel oil would average 1,700 to 1,800 gallons per day. Gasoline for vehicles would be stored in a 5,000 gallon underground tank, to be dispersed by a standard pump. Spill prevention would be in accordance with EPA regulations on oil pollution prevention, 40 CFR 112.

Depending on water conditions encountered in the mining process, either ammonium nitrate-fuel oil (ANFO) for dry holes, or a water-gelatin explosive for wet holes would be used as the blasting agent. For security purposes, explosives would be stored within the mine and a surface powder magazine.

t. Reagent Storage

Xanthate (potassium amyl xanthate) would be supplied to the mill site in a dry form in 300 pound drums and would be stored in a reagent storage building located adjacent to the mill. Pineoil (terpineol) and Dowfroth 250 (Glycol methyl ether) would be delivered to the mill site in 55 gallon drums and stored also in the reagent storage building.

Sodium hydrosulfate (NAHS) would be transported to the mill in a 2,000 gallon capacity tank truck and stored in an above-ground 36,500 gallon storage tank near the reagent storage facility.

u. Mining and Reclamation Equipment

ASARCO currently plans to conduct its own mine development; plant road and pipeline construction, site preparation, and tailing impoundment construction would be contracted to a general contractor and/or subcontractors. The type and size of equipment used by contractors would vary and/or be decided by individual contractors. Therefore types, sizes and numbers of equipment proposed in the following account for contracted services are hypothetical.

Powerline construction would be contracted to Northern Lights, Inc.; completion is expected to occur during the first construction season. Either a crane or boom-lift truck would be required for pole erection, as well as a supply truck, wire-reel truck and one or two support trucks. Site preparation would involve limited use of heavy equipment along that portion of transmission line proposed for upgrading along an existing right-of-way (see Appendix B).

Construction of roads, pipelines, the mining site preparation, and tailing impoundment area would require the use of heavy equipment and is presently planned to be done by a contractor for ASARCO. The work would be done in sequence and completed within the first two years of construction. Site preparation may be done with a combination of back-hoe, dozers with sheeps foot (2), front-end loader, dump trucks (2), tree farmers (2), logging trucks, crane, concrete trucks (2) and support vehicles (5). Road and pipeline construction would utilize a combination of dozers (3), scrapers (3), motor grader, track drill, water truck, crane, dump trucks (2), front-end loader and miscellaneous support vehicles (5). Tailing impoundment construction would require equipment similar to that used on the road. A portable crushing and screening plant would be operated at the impoundment area to utilize mine waste rock for construction. Aggregate would be screened from the tailing impoundment area and would also possibly be obtained from a quarry on ASARCO land south of Bull Lake and then used for construction. Concrete would be provided from a temporary batch plant proposed to operate on the site.

The following equipment would be utilized during the two year mine development period: ST-8 scooptrams (2), 28-ton trucks (2), 3-boom jumbos (3), 1-boom air tracks (2), roof bolt jumbo, personnel carrier, boss buggies (3), lube truck, ambulance, roof scaler, highway tractor-trailer, D8K dozer, Model 12 motor grader, 930 utility loader, 824 dozer, support vehicles (3) and portable air compressors. In addition generators would be needed if power is not available during the development phase. Plant construction would utilize the equipment previously mentioned, as well as 5 vehicles, generators if power is not available and trucks used for transporting material and supplies.

Operation phase equipment would include that listed above for mine development, in addition to 245 hydraulic shovels (2), 35-ton trucks (4), ST-13 scooptram (1), 3-boom jumbo (1), 1-boom air track (3), roof bolt jumbo (1), 2-ton service trucks (4), pickups (8), boss buggies (6), forklifts (2), crane (1), snow plow (1) and portable welders and compressors. Concentrate haulage would be contracted and is anticipated to involve the use of two or three 20-ton, 10-wheeler trucks.

Reclamation during and after completion of the proposed operation would utilize the various types of heavy equipment previously listed. If the development of specialized reclamation equipment should occur during the projected life of the project, the use of this equipment would be fully considered for reclamation activities at the project.

8. Surface Water Control

a. Mine Patio

Main adit alternative location No. 1 or No. 2 would necessitate that the two tributaries of Stanley Creek located to the west of the main portal and the tributary located on the east side would be conveyed through culverts located under the waste patio at the main adit portal The culverts would be concrete, and designed to withstand a 100 year peak flood event. A "grizzly" or coarse screen would be placed at the mouth to prevent coarse debris from entering the culverts.

b. Plant Sites

All tributary surface water resulting from snowmelt or other storm-related precipitation would be captured at the plant sites, escorted through the plant or around it, and then returned to its natural drainage course. Drainage from the plant-site surfaces would be natural. The final location of permanent surface runoff diversion is not known pending completion of additional engineering studies for the project.

c. Road System

Culverts able to withstand a 100 year peak storm event would be used wherever the access road is proposed to cross Stanley Creek or other tributary water courses. Roadside ditching would channel surface runoff to the nearest culverted drainage system.

d. Tailing Impoundment

Ditches would be constructed around the impoundment area to direct surface-runoff water away from the toe of the starter dam. In addition, a ditch would be constructed along the eastern edge of the tailing impoundment to prevent runoff entering the pond from the surface drainage area upslope of the pond. Water diverted from the upslope areas would be directed to the nearest natural drainage for discharge.

9. Water Use

a. Mine Water

Water production from the exploration works in the existing North adit is presently 70 to 80 gpm. With additional drilling and development additional water would undoubtedly be encountered. Water encountered in the mine would be diverted to ditches for transport by gravity to two sumps operating in series for the settling of suspended solids and skimming of oil and grease. Each sump would be of sufficient size to accommodate necessary estimated detention time required to settle suspended solids in the event one sump is inoperable during periods of maintenance and cleaning. If volumes of water are encountered during the mine development larger than anticipated for retention in the sump series or before the sumps can be developed, the water would be piped to the mill water reservoir for clarification before discharge. The mine sumps would be rectangular in shape, excavated in rock along the main adit and equipped with baffels to control velocity, plus subsurface discharge to skim oil and grease. The units would be of sufficient size to be cleaned with mechanized mining equipment (front-end-loader) and sludge recovered would be disposed of in the tailing impoundment area.

Water from the sump would be pumped through a pipeline for distribution and use, either to the surface mill and fire water tank or for use within the mine during normal operations. In mine water use would include the following: dust control for the drilling process, dust control for muck piles (if required), as well as dust control in the primary crusher, wet type dust collectors and air compressor cooling systems. Used water within the mine would be pumped to the mill and fire water tank for use in the mill and concentrator. In addition, a rechargeable 250,000 gallon fire water sump would be developed in the mine for storage and distribution of mine waters to the surface fire hydrant system.

b. Domestic Water

The amount of water needed at the mine and mill for domestic purposes would be approximately 50 gpm. This water would be supplied from a potable water-storage tank at the plant site after chlorination and filtration if required.

c. Mill Water

The milling operation would require a circulating water supply of approximately 4,313 gpm, of which 2,582 gpm would be reclaimable at the concentrate and tailing thickener recycle units. About 44 gpm would be consumed and about 1,417 gpm of water from the tailing thickener would be used to transport tailing to the tailing pond area. Required makeup water would thus be approximately 1,461 gpm.

Water required for the mill would be obtained from three sources: 1) a primary water supply, 2) a supply decanted from the tailing pond and returned to the mill by pipeline and 3) excess mine water supplied from the mine sump.

(1) Primary Water Source

The primary water supply would be obtained from two deep water wells along Stanley Creek in the northeast quarter of Section 13, T29N, R34W, about 2½ miles north of the plant site (Figure I-2). This water supply would be designed for a maximum capacity of 1,700 gpm. The planned operating maximum would be 1,461 gpm.

Initially, a maximum capacity of 1,600 gpm would be needed to operate the mill. After water becomes available for reclaim from the tailing pond, the amount of makeup water required from the well field would be reduced to an average of approximately 257 gpm.

Appendix D contains tables taken from a hydrologic report prepared at the request of ASARCO by the Water Development Company, Tucson, Arizona (Halpenny and Green, 1976). Table 1 in Appendix C, summarizes the theoretical operating demand on the primary water source once water is available in the tailing pond for reclamation.

(2) Tailing Pond

Table 2 in Appendix D summarizes the estimated volume of reclaimable and accumulated water in storage in the tailing pond on a monthly basis. During the winter months snowfall would accumulate, thereby becoming unavailable for reclaim until snowmelt. In addition, an unknown amount of water delivered to the pond with the tailings would be unavailable and in the form of ice for unknown periods of time. This would result in less recovery during the winter months, and greater use of water from the primary source. With spring melting of the snow and ice there would be more water available for reclaim than is needed at the mill and the primary source may not be needed for some period of time.

10. Water Discharge

a. Mine Water

(1) Main Adit

During the mine development period, subterranean water would be piped from an underground sump near the adit portal and discharged for percolation through the broken rock of the adit portal to the ground water system, similar to the way the water is presently being discharged from the north adit. If larger volumes of water are encountered during the mine development than anticipated, the mine water will be discharged as discussed previously.

During production, mine water would be utilized in the mine and the mill and there would be no discharge from the mine unless the mill had water in excess of its needs.

Following completion of mining, all portals would be concreted shut and a provision made to continue discharging mine waters.

(2) South Adit

There would be no increase in the water discharge from the south adit over what is presently occurring. All mine waters encountered in mining the uplifted south ore block, and not used for in-mine purposes, would be directed to collection sumps in the north ore block for distribution to the milling system.

b. Tailing Impoundment

(1) Surface

Discharge of surface water from the tailing impoundment area would be limited to water pumped from the decant barge and discharged into the reclaim water pond via a surface pipeline.

(2) Subsurface

The potential for subsurface seepage of tailing pond water is discussed in detail in Chapter III of this impact statement.

11. Reclamation Plan

The following reclamation plan contains the plans of ASARCO to reclaim those areas disturbed in association with the construction and operation of facilities for the proposed Troy Project Mine. The application of these reclamation plans to the Hard Rock Law in their entirety is uncertain, pending the result of the lawsuit as discussed in the Preface. Regardless of the requirements of the Hard Rock Law, ASARCO has pledged to carry out these reclamation plans on all mine and mill operations related facilities as discussed below.

a. Topography

(1) Mine Site

The slopes of all mine waste dumps would remain at the natural angle of repose. The surface and edges of the waste dumps would be graded in a manner which would allow runoff waters to spread out and prevent erosion of the dump surface. The dumps would be capped with topsoil to aid in revegetation plans. A description of the location, size and physical characteristics of the various adit portals and mine waste dumps can be found in the previous sections of the mining plan.

All adit portals would be concreted shut and water drainage provided upon completion of mining. Post mining water accumulations would be allowed to discharge onto the waste dump patio and infiltrate into the ground water system. ASARCO has applied for a discharge permit from the Department of Health and Environmental Sciences to allow for such a discharge.

(2) Mill Site

The construction of mill facilities and associated ancillary facilities near the mine site would require the establishment of several cut and fill benches on the side of Mt. Vernon. A tentative conception of these benches is shown in Figures I-7 and I-14. The final location and configuration of the benches is dependent upon the finalization of engineering plans and facility siting for the mill site. In general, the surface of these benches would be flat or nearly so to provide drainage. The cut and fill slopes would be approximately 1½ to 1. Revegetation of these slopes would aid stabilization.

ASARCO has not proposed to make any extensive changes in the configuration of these benches upon completion of the mining project and subsequent reclamation. If a suitable reclaimed use for the buildings and associated facilities can not be found after the project is completed, ASARCO would remove the buildings from the sites and grade smooth the remaining bench surfaces. Since the initial cut and fill slopes would have been experiencing revegetation since the start of the mining operation (approximately 19 years), ASARCO has not proposed redisturbing these sites upon removal of the mining and processing facilities.

(3) Access Roads

The mine access road would not be removed following completion of the mining project. The road would remain to provide recreational access to Spar Lake and Mt. Vernon areas. Final disposition of the road, however, would be decided upon by the Kootenai National Forest. All other roads associated with the mining project would be removed and revegetated, pending approval by the Kootenai National Forest. Should the Kootenai National Forest desire that these additional roads remain following completion of the mining project, the maintenance of these roads would become the responsibility of the Forest.

(4) Tailing Line

In additional to the clearance of vegetation and other obstacles to allow for the positioning of the transmission line, tailing pipeline and buried return reclaim water pipeline, some minor cut and fill slopes would be necessary to prepare a base of suitable grade upon which to place the tailing pipeline supports and drop boxes. Revegetation of these areas would occur immediately following the completion of their construction. Upon completion of the mining project, the tailing pipeline, and transmission line would be removed. Disturbances which would occur during the removal of these structures would be revegetated.

(5) Tailing Impoundment

Following completion of the mining operations, the surface of the tailing impoundment area would be graded and reworked to provide a suitable area for revegetation. The surface of the impoundment area would be covered with approximately 18 inches of previously stockpiled topsoil and revegetated. Surface drainage would be provided from the low point on the impoundment surface to an appropriate natural drainage to direct runoff from the tailing impoundment surface.

Prior to completion of the mining project, ASARCO has proposed to construct a small tailing impoundment area adjacent to the main impoundment area for the purpose of experimental tailing reclamation studies involving revegetation. The results of the studies would be used to facilitate a rapid and successful reclamation and revegetation of the tailing impoundment surface, as well as other areas associated with the project.

(6) Tailing Impoundment Dam

ASARCO has not proposed any change in the configuration of the tailing impoundment dam face following completion of the mining project. Topsoiling and revegetation of the dam face would occur concurrently with the project operations and dam construction.

b. Soils

ASARCO has proposed to salvage topsoil from soil mapping Unit No. 1 (see Chapter II), in the east half of Section 31, T30N, R33W to a depth of two feet over an area of 40 acres. This soil would be used to provide an average 12 inch cover over the waste dump and provide additional material for cover around the buildings and facilities.

One hundred sixty-two thousand (162,000) cubic yards of Unit No. 1 topsoil material would be temporarily stockpiled in Section 32, as shown in Figure I-18. It would be revegetated to prevent loss by wind and water erosion. An additional 847,000 cubic yards of topsoil would be stockpiled outside the perimeter of the tailing dam for later use in reclaiming the dam and impoundment area. The stockpiles would be irregular shaped piles located on the bench above the limits of the probable maximum flood of Lake Creek.

c. Revegetation

A mixture of grasses, legumes, shrubs and trees would be used to revegetate all disturbed areas. The mixture of grass and legume species proposed to be used contains:

Timothy (*Phleum pratense*)	3
Hard Fescue (*Festuca ovina*)	5
Orchard grass (*Dactylis glomerata*)	5
Blue grass (*Poa spp.*)	4
Brome (*Bromus spp.*)	6
Sweet clover (*Melilotus spp.*)	2
	25 pounds/acre

It is anticipated that container-grown trees and shrubs would be planted, including:

Ponderosa pine (*Pinus ponderosa*)
Douglas fir (*Pseudotsuga menziesii*)
Western larch (*Larix occidentalis*)
Ceanothus (*Ceanothus spp.*)
Serviceberry (*Amelanchier alnifolia*)
Alder (*Alnus spp.*)
Willow (*Salix spp.*)

Reclamation and revegetation would be as concurrent with development and mining operations as possible, and would be completed within two years after cessation of activity. Revegetation would be accomplished in the first appropriate growing season after necessary surface grading and preparation. Fertilization rates would vary with the revegetation location. Should initial revegetation attempts fail, ASARCO would seek the advice of the Department of State Lands and Kootenai National Forest before making another attempt.

(1) General Plant and Facilities

The cut and fill slopes that would result from the construction of the mill, various support facilities, waste dumps, access roads, utility corridors and other disturbances associated with the proposed project would be seeded with the proposed grass and legume mixture. A complete fertilizer (including micronutrients) would be applied at the rate of 200 pounds per acre. South-facing exposures would be mulched immediately after seeding and fertilization. Tree and shrub species would be seeded on cut and fill slopes as well as on the flat sites to aid in soil stabilization and landscaping. It is anticipated that considerable invasion of native trees and shrubs would take place on the fresh cuts and fill, and this would provide additional stabilization.

(2) Tailing Impoundment Dam

The slopes and benches of the tailing impoundment dam would be capped with one to two feet of topsoil. Ponderosa pine, Douglas fir and Western larch would be planted on the benches with an eight foot spacing between trees. The shrub species would be planted on the benches between the tree species. The slopes between the benches would be seeded with the grass and legume mixture at the rate of 25 pounds per acre and fertilized. Mulch would be applied to the south-facing slopes after seeding and fertilizing. Subsequent fertilizer applications would depend upon the vigor of the grass and clover. As the tree species became established, the grass and clover on the slopes would be anticipated to invade the benches to form a complete vegetation cover.

Beginning the second year after transplanting, the tree species would be fertilized with two ounces of nitrogen (ammonium nitrate or urea) once every two years. The slopes and benches would be irrigated only if research on the experimental impoundment area indicates that plant survival and growth could be significantly improved.

(3) Tailing Impoundment Surface

Following completion of the mining project, and preparation of the surface of the tailing impoundment for reclamation and revegetation one to two feet of topsoil would be spread on the surface. Container-grown Ponderosa pine, Douglas fir and Western larch seedlings would be planted with an eight-foot-by-eight-foot spacing (680 trees per acre). Container-grown native shrubs, such as Alder, Ceanothus, Serviceberry and willow, would be planted among the tree seedlings to provide improved wildlife habitat and diversity. After two to three growing seasons, the grass and legume mixture would be seeded to provide complete vegetation cover Once every three years, beginning the second year after planting, each tree species would be fertilized with two ounces of nitrogen.

The topsoil stockpile areas would be stabilized with the grass and legume mixture until the time they would be ready for use. After the stockpile has been depleated, the site would again be revegetated and planted with tree and shrub species.

(4) Experimental Tailing Impoundment

Prior to completion of the mining project, ASARCO has proposed to construct a small tailing impoundment area adjacent to the primary impoundment area for the purpose of experimental tailing reclamation studies involving revegetation. The results of the studies would be used to facilitate a rapid and successful reclamation and revegetation of the tailing impoundment surface, as well as other areas associated with the project. The research is proposed to include investigation into the following:

1. Final configuration of the pond's surface and various types of surface disturbances (trenches, mounds, etc.)
2. Species of trees, native shrubs, grasses and forbs--determine the best combination for each side of the tailing pond dike and for the pond's surface
3. Topsoil--best method of applying and stabilizing it; depth necessary for best plant growth
4. Treatment of dried tailing on pond surface prior to covering with topsoil--ripping, subsoiling, scarifying, etc., to improve root penetration and drainage
5. Effect of tailing material on plant growth--compare vegetation growing on topsoil with vegetation growing on tailing material
6. Irrigation--determine the need for and best type of system
7. Mulching--determine the need for, the best type and best method of application

The results of research on the experimental tailing pond, new development in revegetation methods in general, and on-site experience would all be used to update existing plans for revegetation.

d. Other

In addition to the reclamation plans discussed previously, the following plans for mitigating measures would be conducted concurrently with the construction and operation of the proposed project.

1. All water, tailings or spoil impounding structures would be equipped with spillways or other devices that would protect against washouts during a 100 year flood.
2. All refuse would be disposed of in a manner to prevent water pollution or deleterious effects on revegetation efforts. ASARCO would comply with applicable county, state and federal laws regarding solid waste disposal.
3. If construction of earth dams or other devices to control water drainage would become necessary, such structures would not interfere with other landowners' rights or contribute to water pollution.
4. Upon abandonment, water discharge from the development or mining activities would be diverted or treated in a manner to control erosion, siltation or other water pollution to streams and natural water courses.
5. All access, haul and other support roads would be located, constructed and maintained to control or minimize channeling and other erosion.
6. All operations would be conducted to avoid forest fires and spontaneous combustion.
7. Should any archaeological or historical sites be found during development, excavation would cease and the sites would be given appropriate protection.
8. Stagnant water which could become a breeding ground for noxious insects would not be allowed to accumulate in the development area.
9. All final grading for reclamation would be made with non-noxious, nonflammable and noncombustible solids.
10. Proper precautions (such as use of water truck to water roads, if necessary) would be taken to assure that wind erosion on exposed cuts, tailings or spoil disposal areas would not become a public nuisance or detriment to local flora and fauna.

B. Proposals for Other Developments in the Area

1. Libby Reregulating Dam and 230 Kv Transmission Line

The existing Libby Dam was completed in 1973 with four generators although the powerhouse was constructed to contain a total of eight generators. The addition of the remaining four generators is scheduled for 1983 and would require a reregulation dam downstream from Libby dam to stabilize the main river flow while generating power. Congress authorized the additional generators and reregulation dam in 1975. Construction is to be completed by the additional generators installed by autumn of 1983. The reregulation dam will be 12 miles below Libby dam and four miles upstream from the town of Libby. Construction will require relocation of the Burlington Northern railroad tracks and relocation of the St. Regis Company haul road nine miles. State Highway 37 will be relocated for three miles. It is anticipated that this project will take five years to construct and employ 450 people during the period of greatest activity.

An additional 230 Kv electrical transmission line will be required to move the energy produced by the additional generators into the northwest power grid. Bonneville Power Administration is presently determining the most feasible route for this line. The line will be from 115 to 143 miles long ending in the vicinity of Spokane, Washington. Construction will start in 1980 and end in 1983. Depending upon the route taken construction will add between 150 and 170 jobs to the area during this period.

2. Kootenai Falls Project

Northern Lights Inc., a Sandpoint, Idaho, based REA Co-op serving northern Idaho and northwest Montana, has obtained a license from the Federal Power Commission for a three year feasibility study to construct a hydrogeneration facility in the vicinity of Kootenai Falls, approximately 12 miles west of Libby. The proposal calls for a structure across the river that would raise the water level in the river approximately 12 feet and backup water approximately two miles. The facility would divert water from the river into a tunnel leading to an underground generator room. Water would be returned to the Kootenai River below the falls by way of another tunnel. This generation facility would produce 140 MW of power in two 70 MV generating units. Construction would take five years and employ 150 people. This facility would not involve any length of transmission line to tie into the northwest power grid.

3. Improvement of Highway 2 Between Libby and Troy

Improvement of Highway 2 from Troy to Libby, Montana, has been scheduled by the Montana Department of Highways. The improvement will involve 18 miles of heavily used Highway 2. Because of the narrow canyon and limited space most of the work would be reconstruction. Project completion is scheduled for the mid 1980's.

C. Existing Mineral Mining in the Area

1. Mineral Claims

The Libby-Troy-Bull Lake area has a high potential for prospecting and mineral development activity. (MACS 1, R. Wallace 1976) Prospecting activity has occurred in this area for a long time. Courthouse records indicate at least six claim groups consisting of 164 mining claims in the portions of Lincoln and Sanders Counties adjacent to the ASARCO proposal. Primary minerals of value on these claims are copper and silver. Prospecting and exploration work on these claims has ranged from hand work to extensive dozer work and core drilling. Since the ASARCO proposal, prospecting and exploration activity has increased. Initial staking of claims that resulted in the ASARCO proposal started in 1963. Approximately 600 claims were staked of which 448 are still valid. Patent was applied for and received of 24 of these claims.

2. Mineral Mining

There are no producing mines in the area at this time. Prior to 1940 several small mines in the Clark Fork Valley between Clark Fork, Idaho and Heron, Montana produced quantities of lead, zinc and silver ore.

During the period from 1910 to 1940 there were several producing mines south and southwest of Troy, Montana. These mines were in Callahan Creek, Keeler Creek, Iron Creek and on Grouse Mountain. Lead, zinc and silver were the minerals produced. These mines were not large but did occasionally produce ore until about 1940. There have been no producing mines in the Troy area since 1940.

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. The Physical Environment

1. Location and Description of the Area

The general area described in the EIS lies in the Cabinet Mountains of extreme northwestern Montana (Figure I-3). The area lies adjacent to the Scotchman Peak New Study Area that will be studied for an addition to the National Wilderness system. Section A. 1. c., Page 15 presents a specific description of the location of lands directly affected by the proposed ASARCO Troy Project. Of necessity, some of the studies involved in this EIS are not limited to the area described in the ASARCO plan of operation. These increased study areas vary from a couple of miles to large portions of Lincoln and Sanders Counties in Montana, and Boundary County in Idaho. A delineation of the extent and location of areas considered in the evaluation of the potential impacts of the project is contained in each appropriate subject discussion.

2. Topography

The erosive force of water has done much to shape the present topography of the area. This force has been influenced by the type of bedrock (its resistance to erosion) and the folding and faulting that have resulted from shifting of the earth's crust. Compounding the work of this erosive force was the force of the advances and retreats of masses of ice that occurred during the Pleistocene epoch. The ice was separated into two categories--continental and alpine. The continental ice mass usually was of such extent that it rode over the landscape scouring and filling as it advanced. Since ground evidence indicates that a continental ice mass extended to just beyond the junction of the Bull River with its East Fork tributary, this ice mass was not as powerful an erosive force as it was further north where the ice was much thicker. Probably the larger influence on the shape of the landscape in this area by the continental ice mass was the soil material carried by its melt waters. This is evidenced by the extensive outwash benches in the Lake Creek Valley. Both the west and northeast boundaries of the Bull Lake Valley exhibit the rugged topography associated with alpine ice masses. This landscape is characterized by U-shaped valleys, cirque basins often with lakes, and craggy peaks between the valleys, all of which add to the rugged appearance as opposed to that associated with continental glaciation.

Mt. Vernon has an elevation of 5800 feet and is characterized by steep slopes (45-70 percent) with a dense coniferous tree cover. The slope is broken with narrow benches and a drainage pattern of small steep gradient streams with deep V-shaped channels. The north slope of

Mt. Vernon is drained by Stanley Creek. The upper reaches of this stream are characterized by steep gradients with narrow deep V-shaped channels. The lower reaches of Stanley Creek to its confluence with Lake Creek has a gentle gradient with a broad shallow U-shaped channel. The land adjacent to the lower reaches of this stream is gentle rolling to flat.

Bull Lake lies on the east side of Mt. Vernon and is 1250 acres in size at an elevation of 2324 feet. Lake Creek drains from the north end of Bull Lake and flows northward 18 miles to its confluence with the Kootenai River.

Lake Creek is characterized by a gentle gradient as it flows through a broad valley bottom. The stream channel is broad and shallow U-shaped with many deep pools.

3. Climate

The climate in the proposal area is the cold snow forest type characterized by heavy snowfalls from November through March with short, warm summers. Due to the variations of elevation within the area large ranges in temperature, precipitation totals, forms and runoff amounts result.

Winds, precipitation and temperature patterns in this part of Montana are under the influence of the Pacific maritime air mass both winter and summer. Occasionally a cold arctic air mass will spill over the Continental Divide and replace the maritime air mass for a short period of time.

The majority (65 percent) of the precipitation occurs in the form of snow during the winter months. High stream flows normally occurring during the late spring with low flows occurring during autumn or winter.

Climatic data has been collected continuously by the National Weather Service at the Troy Ranger Station since 1961. Data from 1967-1976 is summarized in Appendix E. Troy is located 15 miles north of the project area at an elevation of 2120 feet above mean sea level. Highest point within the project area is 5800 feet on Mt. Vernon.

a. Precipitation

Under the influence of a Pacific maritime air mass with predominantly westerly air flows, and the large variations in elevation within the area precipitation amounts vary greatly. Storm frequency related to this air mass is highest during the colder winter months with the precipitation occurring as snow. Winter storms are generally of several days duration. Generally at least one January storm is influenced by a warmer than normal air mass and produces heavy rain on the snow pack to approximately 6,000 - 8,000 feet elevation. Summer precipitation (June - August) usually occurs as thunderstorms which are generally high intensity and of short duration.

Average annual precipitation totals vary from less than 40 inches along Bull Lake to over 100 inches on Mt. Vernon and the headwaters of Stanley Creek. Annual snowfall totals will vary from near 200 inches in the Lake Creek drainage to over 700 inches in the higher elevations near Mt. Vernon. Average maximum snow depths vary from less than two feet on south-facing slopes below 3800 feet to more than 12 feet at the higher elevation north-facing slopes.

b. Temperature

Seasonal and daily variations between maximum and minimum temperatures are often extreme in the project area. Daily variations of 35° to 50° F are common as a result of low humidity and strong terrestrial (ground) radiation. Temperatures at Troy range from -25° to 105° F. Ranges at Mt. Vernon probably vary more due to elevational differences. The yearly mean temperature at Troy is 42.6° F.

The growing season (continuous days above 32° F) for Troy is 104. The growing season in the project area could be reasonably expected to average 10 days shorter.

The effect of the moist, warm, Pacific maritime air mass is to modify the mean temperatures, et. al., by holding the extremely cold arctic air masses to the east of the continental divide especially during the winter months. Normally heavy snowfalls insulate the ground leaving the soil temperatures under the snow blanket above freezing throughout the winter.

c. Wind

Wind direction is primarily westerly under the influence of the Pacific maritime air mass during the entire year. Locally surface winds are influenced by the Cabinet Mountains with some wind channeling occurring in the stream valleys and saddles. No wind velocity data is available for the proposal area or the weather recording stations at Troy or Heron, Montana. The highest wind velocities occur at the higher elevations during the winter months. Thermally induced diurnal up valley and down valley flows occur during the summer months.

Occasionally during the winter months a cold arctic air mass will displace the Pacific maritime air mass with accompanying cold temperatures and strong northeasterly and easterly winds for several days.

Summer thunderstorms also induce strong winds in the vicinity of the thunderheads.

d. Evaporation

Evaporation is controlled primarily by temperature, solar radiation, relative humidity and wind velocity. Data from the National Atlas show the mean annual evaporation from a class A pan in this general area to be approximately 40 inches per year (USGS 1970). Gross evaporation from reservoirs and evaporation ponds would be about 28-30 inches of water per year.

The majority of the evaporation occurs during the period April through October when temperatures are high and humidity is low. Low temperature and high humidity during the period from October to April reduce evaporation to a minimum.

4. Air Quality

The Bull River valley has a north-south orientation with the mountains rising to more than 5000 feet above the valley floor on each side. Since the predominant synoptic wind flow is a westerly, these mountains tend to block the flow in the valley preventing the normal flushing action of the wind. Frequent low level inversions also tend to trap air pollutants in the area. The inversions act as a lid on a box created by the valley walls. Any air pollutants emitted are trapped in the valley until the inversion is removed by solar heating or strong winds. Upslope and downslope winds caused by differential heating on the valley walls keep the air mixed below the inversion but again the air pollutants cannot escape until the inversion is broken. Normal night time downslope winds would tend to accumulate in the valley bottoms, any air pollutants emitted during the night. The potential for air pollution problems caused by meteorological conditions is greater during the fall and winter season. During these seasons, the decrease in solar heating hours and the reflection of solar insolation by snow cover prevent the inversions from being removed. Frequent high pressure systems during the fall-winter season cause inversions in this area to persist for several days at a time, during which time any air pollutants emitted will continue to accumulate in the valley. During the spring and summer season, increased wind speeds and increased convective activity reduce the chance of air pollutants to be trapped in the valley.

Table II-1 Total Suspended Particulate (ug/m^3)

DATE	BROWN SITE	SAMPSON SITE
04/25/77	122	
05/01/77	85	
05/07/77	32	
05/13/77	58	
05/19/77	11	
05/25/77	8	
05/31/77	26	
06/06/77	64	
06/12/77	33	
06/18/77	14	
07/24/77	45	
07/30/77	56	
08/05/77	40	
08/11/77	171	
08/17/77	99	
08/23/77	89	
08/29/77	18	
09/04/77	15	7
09/10/77	72	29
09/16/77	42	22
09/22/77	43	33
09/28/77	27	16
10/04/77	76	20
10/10/77	59	9
10/16/77	73	19
10/22/77	105	15
10/28/77	94	22
11/03/77	57	14
11/09/77	60	7
11/15/77	32	4
11/21/77	108	13
11/27/77	42	2
12/03/77	32	5
12/09/77	30	10
12/15/77	90	8
12/21/77	61	10
12/27/77	52	15
01/02/78	21	8
01/08/78	31	3
01/14/78	29	7
01/20/78	41	17
01/26/78	40	14
02/01/78	20	11
02/07/78	33	16
02/13/78	120	29
02/19/78	43	11
02/25/78	110	12
Geometric Mean	45.6	11.3

Table II - 2 Ambient Air Quality Standards - TSP

Agency	Averaging Time Annual Average (Geometric Mean)	24-hour Average
State of Montana	75	200(1)
Federal Primary	75	260(2)
Federal Secondary	60	150(2)

(1) not to be exceeded more than one percent of the days in a year.

(2) not to be exceeded more than once per year.

As can be seen from the data, neither station has recorded a violation of the annual standard. However, a full year's data have not been collected and thus a true comparison with an annual standard cannot be made. The data, through February 1978 indicate rather low overall levels of TSP.

One 24-hour average (Site 1 08/11/77) has exceeded the federal secondary standard, but is not a violation as one reading per year above the standard is permitted. No readings greater than the federal primary 24-hour standard have been observed. As a general statement, the federal primary standards are designed to protect human health, while the secondary standards are oriented toward human welfare - effects on vegetation, animals, materials, economic losses, etc. Additional discussion of the ramifications of the standards is contained in the sections on agency responsibilities and impacts of the proposal.

c. Particle Size

Particle size data is being collected at the Sampson site with the use of a hi-vol sampler with an Andersen cascade impactor head. This unit consists of five separate filtering stages in series which trap the particulates of different sizes as the sampled air passes through the filter stages. This data is rather important in that the size of the particulate has a significant bearing on the effects of particulate

a. Sampling Program

The Department of Health, Air Quality Bureau, is conducting a background sampling program to determine levels of particulate matter in the Troy-Bull Lake area. Figure II-1 shows the locations of the sampling sites. Originally, an additional site was proposed, but suitable location and permission could not be arranged. The sampling program and data collection will be continued until May and additional data from the sampling will be included in the final EIS. Currently, two stations are being operated. Data and samples collected are being used to determine levels of total suspended particulate, particle size distribution, trace element concentration and wind speed and wind direction. Site #1 is located at the Brown residence in Troy and is equipped with a total suspended particulate sampler, as well as a wind system for determining wind speed and wind direction. Samples from this site are also analyzed for trace elements. Site #2 is located at the Sampson property near Little Joe, Montana, in the general vicinity of the proposed tailing impoundment. This site is equipped with a total suspended particulate sampler, particle size sampler, wind system and a third particulate collecting device (membrane filter) for sample collection for elemental analysis.

Total suspended particulate, a measure of "dust" in the ambient air, is collected by a high-volume sampler (hi-vol), collecting a 24-hour sample once every six days. Particle size data is collected on a high-volume sampler equipped with an Andersen cascade impactor, collecting a six-day sample every six days, following the hi-vol schedule. Samples for trace element analysis are collected in two modes. The hi-vol filters from the total suspended particulate sampling are used and analyzed for 18 elements. In addition, a membrane filter sampler is being employed at the Sampson site to collect samples for elemental analysis. The membrane filter is being employed because of its low background levels of trace elements.

b. Particulate

Total suspended particulate (TSP) is being collected at the two stations previously mentioned. TSP is a measure of the amount of dust, dirt, other solid and liquid material which are suspended in the ambient air. Sources of TSP are such things as industrial discharges, automobile exhaust and tire wear, dust suspended by vehicle traffic on paved and unpaved roads and wind-entrained dust from soils.

Table II-1 summarizes the data collected at the two stations for total suspended particulate. All data for TSP is presented in units of micrograms per cubic meter (ug/m^3). State and federal ambient air quality standards are expressed in the same units. Table II-2 depicts the state and federal standards.

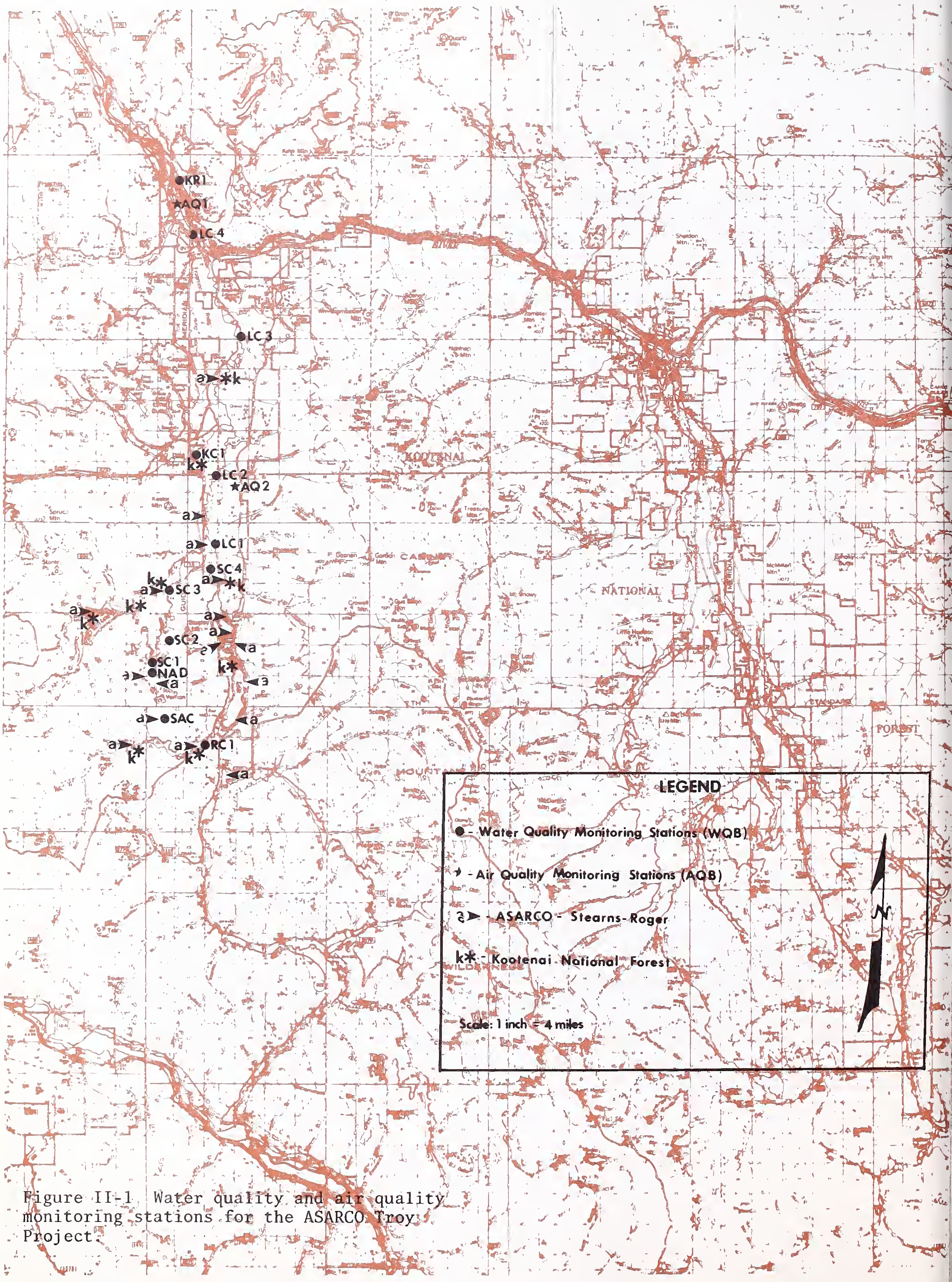


Figure II-1 Water quality and air quality monitoring stations for the ASARCO Troy Project.

on human health. The larger particles do not normally reach the lungs as they are trapped by the nose and throat, while the smallest sizes tend to remain in the air stream and are thus inhaled and exhaled. It is the "intermediate" size particles, those in the range from about 1 micrometer, or micron, to about 3 microns that pass the nose and throat interceptory mechanisms into the lungs, and are retained in the lungs. Gathering particle size data permits some gross estimation of the sources of the particulate, as various source categories have a characteristic particle size distribution to their emission. Table II-3 contains the particle size data collected through February 1978. The data are expressed as a percent of total particulate weight.

Table II- 3 Particle Size Distribution

	Percent of Total Particles in Range				
DATE	>7 u	+3.3 u - 7.0 u	3.3 - 2.0 u	2.0 - 1.1 u	<1.0 u
1977					
09/01 - 09/07[1]	40	Neg.	Neg.	Neg.	60
09/07 - 09/13	31	19	12	10	28
09/14 - 09/20	32	15	11	8	33
10/15 - 10/21	19	14	11	13	42
10/21 - 10/27	25	14	12	13	37
10/27 - 11/02	12	8	8	14	58
11/15 - 11/11	16	Neg.	10	Neg.	74
12/15 - 12/21	31	0.8	12	Neg.	56
1978					
01/07 - 01/13	9	Neg.	8	24	59
01/25 - 01/31	8	8	8	18	58
02/15 - 02/21	16	16	9	0.4	58
Arith. Average	21.7	8.6	9.2	9.1	51.2

[1] The data collected to date indicate that about 30.3 percent of the total falls into the larger size ranges (i. e., greater than 3.3 microns), 18.3 percent of the total is in the "respirable" range and 51.2 percent is submicron in size.

As a general statement, the particle size data indicate that the sources of the particulate in this area are fugitive dust, smoke and windblown soil. The large percentage of TSP in the submicron range also indicates that visibility reductions corresponding to various levels of TSP are more noticeable. Because the smaller particulates have a significantly greater surface area than do larger particulates of the same total weight, the smaller particulates scatter light to a greater degree than do the larger particulates. An example of this phenomenon is demonstrated by the forest fire or slash burning. The smoke from such a combustion source as a forest fire or slash burn can result in reductions in visibility from greater than 50 miles (or clear), to less than three or four miles. At the same time, the total suspended particulate readings, all other factors remaining the same, will show almost no measurable effect. The particulates emitted from a combustion source such as a forest fire are very small in size and large in number, but weigh very little. Therefore, the air will contain a large number of particles of very little total weight. Hence, measurement of total suspended particulate does not indicate the effect of the smoke on visibility.

d. Trace Elements

Atomic absorption spectrophotometry has been performed on hi-vol filter papers and membrane filter papers to determine the concentrations of various trace elements in the particulates sampled. The membrane filters were employed as a filter media as the filters themselves have very low background concentrations of trace elements, thus resulting in more accurate, repeatable lab analyses for the various elements. The hi-vol filters were also analyzed for the same trace elements to allow for the establishment of correlations between membrane filter and hi-vol filter.

Analyses for trace elements were performed on the filters collected between April and October 1977 for 18 different elements. The large number were chosen as a screening technique, fully expecting that analyses for many would show negligible quantities present. This expectation was realized and additional elemental analyses were limited to the six which were found in measurable quantities. Originally, analyses were performed for silver, aluminum, arsenic, boron, beryllium, cadmium, copper, iron, lead, manganese, molybdenum, nickel, antimony, selenium, tin, vanadium and zinc. The six elements found to be present in measurable quantities are aluminum, copper, iron, lead, manganese and zinc. Table II-4 shows the results of the analyses.

Table II- 4 Trace Element Analysis

		Average Concentration ug/m^3	
	Sampson - membrane (18 samples)	Sampson - hi-vol (26 samples)	Brown - hi-vol (42 samples)
Al (Aluminum)	0.082	0.151	0.32
Cu (Copper)	0.042	0.164	0.122
Fe (Iron)	0.126	0.108	0.783
Pb (Lead)	0.064	0.069	0.156
Mn (Manganese)	0.004	(1)	0.015 (2)
Zn (Zinc)	0.018	0.013	0.028

(1) Only two results: detectable - 0.01 ug/m^3 and below detectable limits - less than 0.01 ug/m^3.

(2) Several samples below minimum detectable limits.

The results of the sampling and analysis provide a data base for future comparisons, but do not indicate the sources of particulate. The concentrations of the elements are quite low and the inherent random nature of the samples create considerable variability in the results. As a general qualitative statement, however, the iron and aluminum values substantiate the expectation that the particulate is primarily native soil.

5. Geology

a. Stratigraphy and Structure

Geologic events have been an obvious influence in the formation of the lands included in the mine proposal. The geology of the area is quite complex, and began with the deposition of a 40,000 foot thick sequence of clay, silt, sand and carbonate materials in a shallow sea basin some 1.5 billion to 600 million years ago.

After deposition and induration (hardening to argillites, siltites, quartzites and limestone, respectively) this vast sequence of sediments was uplifted, folded and faulted. Later the lower portion of the sequence was intruded by numerous metadiorite sills which vary in thickness from a few feet to hundreds of feet.

Further uplift and erosion occurred, followed by subsidence and deposition and further sediments. These deposits do not exist at this time as further erosion and uplift removed these sediments, exposing the 40,000 foot thick sequence of argillites, siltites, quartzites and limestone. During this time many major faults (Hope, Osborne and Leonia) were active.

One hundred million years ago the Kaniksu Batholith intruded the Selkirk Range and similar intrusive bodies called stocks intruded the Salish, Cabinet and Purcell Ranges. The region underwent further uplift and erosion accompanied by block faulting 65 to 45 million years ago. The Purcell and Rocky Mountain trenches as well as the Bull River-Lake Creek Valley are believed to have formed at this time. These trenches or valleys are down-dropped fault blocks and are flanked on either side by faults. One and a half million to eight thousand years ago the ice receded leaving a mantle of glacial deposits of varying thickness overlying bedrock. Melt waters from the receding ice and subsequent erosion have downcut through much of the remaining glacial deposits resulting in the present topography.

The present topography of the study area has been strongly influenced by faulting and subsequent erosion by ice. Tongues of continental ice moved south through the Bull River-Lake Creek Valley and terminated near the mouth of the East Fork of Bull River. The resulting subdued topography contrasts sharply with the rugged alpine glaciated Cabinet Mountains on either flank of the Valley. Alpine ice movement and scouring action occurred in both a westerly and easterly direction merging with continental glaciers in the main Bull River-Lake Creek Valley.

The major structural feature is the down-dropped fault block occupied by the Bull River-Lake Creek Valley. Two major north-south trending faults are located on either side of the valley.

The fault on the west flank divides adjacent to Bull Lake and subsequent erosion along the trace of this fault splay has resulted in spectacular rock cliffs and spires. A similar smaller north-south trending fault controls portions of the north and south forks of Ross Creek. Numerous northeast trending faults occur in the study area. One such fault controls Spar Creek. One major fold, a north-south trending syncline runs along the west side of the study area. This fold has been offset to the west by the fault that occupies Spar Creek. Bedrock on the west flank of the anticline dips 10° -20° to the east and on the east flank of the anticline dips 10° -20° to the west. Dip of the bedrock east of the Bull River-Lake Creek Valley is somewhat steeper 20° -50° to the west and is probably related to differential tilting of the beds on either side of the down-dropped fault block.

The sediments laid down in the ancient sea basin have been broken into a number of formations or groups of rock type sequences. In the proposal area the rock sequence generally gets younger from west to east. A sequence of calcareous argillite and quartzite and limestone is the oldest group and occurs in the area northwest of Spar Creek, the tops of Mt. Vernon and Spar Peaks and most of the area east of the Bull River-Lake Creek Valley. This group is followed age-wise by a sequence of which occupies the center portion of the proposal area. A portion of this sequence of rocks contains stratabound mineralization which is normally associated with the quartzites. The youngest of the sea basin sediments is a sequence of argillites and quartzites which occurs in the Pheasant Point-Lower Madge-Camp Creek area.

A portion of a granitic intrusive stock consisting primarily of granodiaritic occurs in Crowell and Dry Creeks and the upper portion of Camp Creek. Glacial and alluvial deposits are found scattered throughout the proposal area, mainly in the Bull River-Lake Creek Valley and larger tributary valleys.

b. Earthquake Hazard

The study area is in Zone 2 of a seismic risk map of the United States (Coffman and Van Hake 1973). Zone 2 covers areas in which the recorded history of earthquakes indicates that moderate seismic damage should be expected. Moderate damage corresponds to intensity MMVII (modified mercalli intensity scale of 1931). At this intensity damage is negligible in buildings of good design and construction, slight in well built ordinary structures and considerable in poorly built or badly designed structures. The seismic risk map is based on a relatively short history of recorded seismic events. Consequently it can give only an estimate of the true hazard. Past earthquake history in western Montana indicate sizable earthquakes can be anticipated in the Troy area.

c. Mineral Resources

Based upon available geological, geotechnical, geophysical, structural information and upon recorded and reported mineral related activities, four mineral activity classification subunits (MACS), have been delineated by the USFS within the general project area.

1) MACS-1

The MACS-1 unit occurs primarily along the West Cabinet Mountains located west of Highway Route 202. According to Johns (1970), highly faulted and folded rocks of the upper part of the Precambrian Ravalli

Group are exposed throughout most of MACS-1. Rocks of Precambrian Wallace Formation are exposed in the vicinity of Mt. Vernon, T29N, R33W and T29N, R34W and just south of Ross Point, T28N, R34W. In general, mineralization has occurred along or adjacent to fault structures.

Preliminary investigations by the U. S. Geological Survey and the U. S. Bureau of Mines in the Scotchman Peak New Study Area indicate that the potential for the discovery of economic disseminated copper-silver deposits within portions of MACS-1 is very high (USGS 1976). The Mt. Vernon deposit is the most significant stratabound copper to date within MACS-1.

Prospecting and exploration activity within MACS-1 has been intense, and at present MACS-1 is given a very high exploration to high production potential for mineral related activity.

Other important mineral exploration within MACS-1 is related to stratabound copper occurrences varying in size, similar to the Mt. Vernon deposit. These occurrences are located in: 1) Star Gulch, 2) Ross Point area and 3) Squaw Peak area. Those occurrences have not yet been fully evaluated, but could be determined to be mineable ore bodies in the future.

Although the westernmost portion of MACS-1 does not at present appear to have quite so high a mineral potential as the rest of MACS-1, there is not sufficient basis for its subdivision.

2) MACS-2 and MACS-3

MACS units 2 and 3 occur primarily along the Cabinet Mountains east of Highway Route 202. Rocks of the Precambrian Wallace Formation and intrusive granodiorite and metadiorite are exposed in MACS unit 2 (Johns 1970). The predominant structural feature is the north-south trending Bull Lake fault. Many small mining properties are located to the north and are related to the same geologic environment. To date some prospecting activity has been reported in MACS-2. The area is currently given a high prospecting to low exploration potential for mineral related activity.

MACS-3 has been delineated by the presence of a large granodiorite stock, which intrudes the Precambrian Wallace Formation. Very high magnetic anomalies have been recorded in the area and there has been some structural deformation of portions of the contact between the granodiorite and the surrounding country rock. No mineral occurrences are known to exist in the area, but a geologic environment and structure favorable to mineralization are present. The geologic environment in MACS-3 is also similar to the environment north of the area where many small mineral properties are located. MACS-3 is given a high prospecting potential for mineral related activity.

3) MACS-4

Rocks of the Precambrian Wallace Formation are exposed within MACS-4, which occur in the southern portion of the Cabinet Mountains east of Highway Route 202. Geologic structure within the area is not well known. MACS-4 is currently given a medium prospecting potential for mineral related activity, but it should be noted that this classification is based upon very limited information.

d. Other Minerals

Mines in the general area during the period 1900-1940 produced lead, zinc and silver ore. There is no indication of present prospecting or exploration for other minerals. The area has a high potential for mineral related activity, however. As more information is available concerning the geology and structure of area, it is probable that additiona mineralization will be found.

The geology and structure do not indicate the likely presence of gas and oil deposits. To date there has been no activity related to gas or oil exploration in the area.

There are no known or suspected geo-thermal formations in the study area. Prospectors and exploration companies have shown no interest in activities of this nature.

6. Soils

a. The Soils Resource

Soils in the Mount Vernon-Lake Creek area support a dense natural diverse plant cover. This cover is primarily coniferous trees and related brush and grass species. Both the private and National Forest lands in the area provide timber for the local economy and game range for the wildlife population. The soils in the area are highly productive except for a small percentage of steep, rocky, almost talus slopes.

b. Soil Types

A soil survey of the area was conducted by Montana Testing Laboratories, Inc. (Stearns-Roger 1975). The survey covered portions of the Stanley Creek drainage and the upper part of the Lake Creek drainage. The elevation range was 3,800 feet on the south end of the area to 2,300 feet on the north end along Lake Creek (see Section 6 and Appendix C). The entire area has been subjected to extreme glaciation. Characteristic deposits of rounded and sub-rounded rock fragments indicative of continental glaciation are found in the valley occupied by Bull Lake and Lake Creek. Alpine glaciation is believed to be the source of depositions found in the Stanley Creek drainage. The Stanley Creek deposits contain a higher proportion of rock fragments that are flat, angular or subangular. The majority of rock fragments in the area are derived from argillites and quartzites of the Belt Supergroup. The entire area is covered with a surface deposit of wind blown material ranging from 10 to 18 inches in depth and is usually reddish brown in color (Kuennen, 1977).

Observations were made on steepness, length and shape of the slopes, texture, structure, color, parent material, rocks, vegetation, climate, precipitation, and other aspects of the environment which relate to soil development. Samples taken were screened, then analyzed for pH, conductivity, sodium absorption rate (SAR), texture mechanical analyses (hydrometer method), nitrate nitrogen (diphenyldisulphonic acid), boron, and the micronutrients (zinc, iron, copper, manganese).

The observations and laboratory analyses were evaluated and soil series were delineated. The series were subdivided into phases according to differing surface textures which would affect man's management of the soil. Once classified, the soils were mapped, first on aerial photographs, then on topographic maps. The final delineations were presented in Figure II-2.

Soil classifications are termed units and are numbered one through five indicating progressive degrees of certain characteristics. Unit 1 has the lowest slope and fewest large rock fragment. Unit 5 is very steep and mountainous with several bedrock outcroppings. Unit 1 is a suitable topsoil source to a depth of five feet, Unit 2 from six to twelve inches. The other units are unfit for use as topsoil due to their high percentage volume of gravels, cobbles, and stones.

(1) Unit 1

This unit consists of deep soils on terraces. The most extensive soil has a 12 to 18 inch brown light loam or light very fine sandy loam surface layer. This is underlain by a 14 to 20 inch gray colored light loam, light very fine sandy loam or light fine sandy loam subsoil layer which has rust colored mottlings and is very hard when dry and brittle when moist. Loose fine and/or medium sands are at depths between 40 and

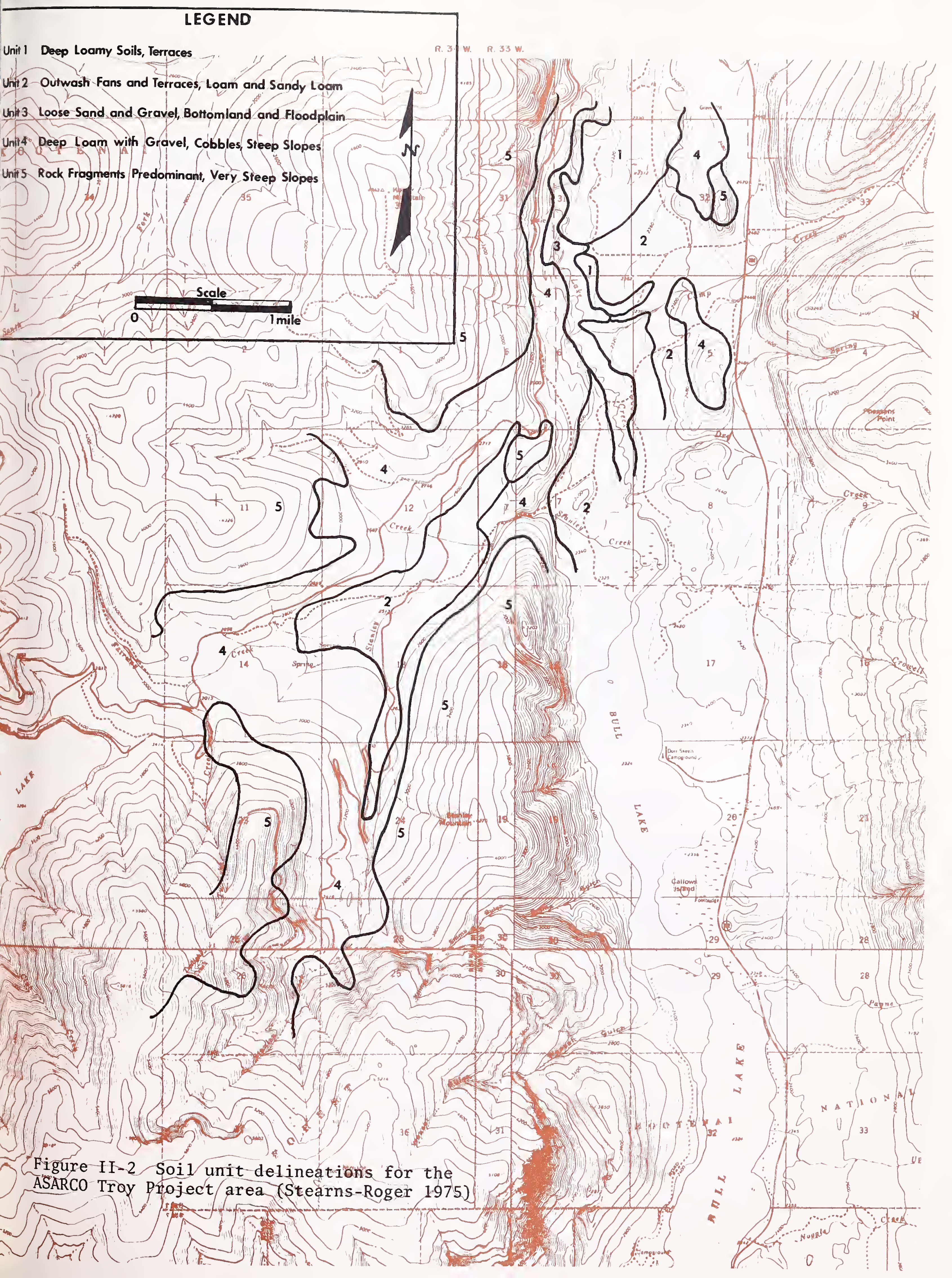

LEGEND
Unit 1 Deep Loamy Soils, Terraces
Unit 2 Outwash Fans and Terraces, Loam and Sandy Loam
Unit 3 Loose Sand and Gravel, Bottomland and Floodplain
Unit 4 Deep Loam with Gravel, Cobbles, Steep Slopes
Unit 5 Rock Fragments Predominant, Very Steep Slopes
N
Scale
0
1 mile
R. 34 W.
R. 33 W.
KOOTENAI
Stanley Creek
Stanley Mountain
BULL LAKE
Dorr Skeels Campground
Gallows Island
Footbridge
Pleasant Point
Spring
Camp
Creek
Gulch
KOOTENAI NATIONAL

Figure II-2 Soil unit delineations for the ASARCO Troy Project area (Stearns-Roger 1975)

60 inches below the surface. Typically there are no gravels or other rock fragments in these soils; however, in places, particularly near the boundary with Soil Unit 2, a few coarse fragments are present on the surface and in upper part of soil.

Small areas of soils that lack the brittle subsoils and have the sands at depths of less than 40 inches are included with this unit.

The soils in this unit have a very low clay content. The available water holding capacity and the nutrient level are both low or very low.

The soils in this unit can be used for topsoiling materials to a depth of five feet or more.

(2) Unit 2

This unit consists of a wide variety of soils on the gently sloping to sloping outwash fans and terraces. Dominantly the soils are loam, very fine sandy loam, or fine sandy loam containing from about 25 to over 50 percent by volume of gravels, cobbles, and stones in the 10 to 40 inches. Below these depths, the materials are loose sands with more than 50 percent by volume of gravels, cobbles and stone sized fragments.

Soils deeper than 40 inches to gravels and having less than 25 percent rock fragments by volume make up less than 15 percent of the acreage of this unit in small bodies.

Areas of this unit, particularly in Sections 5, 6, 31, and 32 will be underlain by deeper sediments at some depth below five feet.

The soils in this unit are not suitable for use as topsoiling materials because of the large amounts of rock fragments. In places, soil may be selected for topsoiling purposes to a depth of six to twelve inches.

(3) Unit 3

This unit consists of a wide variety of soils on the bottom land and flood plain of Lake Creek. The soils vary widely in texture and content of gravels and cobbles in upper layer. Loose sands and gravels are usually present with a depth of 30 inches below surface. In places, gravel free materials will underlay these soils within depths of six to ten feet. A large part of this unit is subject to flooding during high runoff periods.

The soils in this unit are not suitable for use as topsoiling materials because of content of rock fragments.

(4) Unit 4

This unit consists of deep soils on steep and very steep slopes (30 to 60 percent). These soils have formed in glacial till and other transported materials. The upper one to three feet is very fine sandy loam, loam, or silt loam with 20 to over 50 percent gravels, cobbles and stones. Below these depths, the materials dominantly have more than 50 percent by volume of coarse fragments. These fragments are mainly subrounded and angular in shape and range in size from less than one inch up to about 16 inches in diameter. In places, there are stones and boulders up to three or four inches in diameter imbedded in the soil matrix.

Small outcroppings of bedrock are present in places.

Because of the large amounts of rock fragments and the steepness of slopes, the soils in this unit are not suitable for stripping for use as topsoil materials.

(5) Unit 5

This unit is comprised of the soils on the very steep and mountainous bedrock areas. The soils are predominantly more than five feet deep. They have more than 50 percent by volume of rock fragments of varying sizes and shapes but mainly angular and flat. Areas of soils less than five feet and less than 20 inches deep are present in places, as are outcroppings of hard rock. Slide rock or talus are on some of the slopes below these rock outcrops.

The soils in this unit have too many rock fragments and are on slopes too steep to be used for topsoiling materials.

c. Soil Characteristics and Relationships

The area soils have been formed as a result of both continental and alpine glaciation. Only soil Type 1 has anywhere near a well defined soil profile. This soil is formed from deep glacial fluvial or glacial lacustrine sediments. Typically, these soils have a very fine sandy loam surface layer, brown loam subsoils underlain by a gray very fine sandy loam that is brittle when dry and rust colored mottles. Below a depth of about 54 inches the materials are loose sands.

Representative profile in Section 31, T30N, R44W, about 600 feet south and 1,200 feet west of E¼ corner:

O	2-0 inch - Organic debris consisting of wood chips; decomposed and partially decomposed needles, leaves and twigs and charcoal.
A_2	0-1 inch - Light gray (10YR6/1 when dry) light very fine sandy loam; dark gray (10YR 4/1 when moist) very weak granular structure; soft when dry, very friable and loose when moist and nonsticky and nonplastic when wet.
B_{21}	1-10 inches - Light yellowish brown (10YR 6/4 when dry) light loam; dark brown (7.5YR 4/4 when moist) weak fine and medium crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet.
B_{21}	10-16 inches - Light yellowish brown (10YR 6/4 when dry) light loam; dark yellowish brown (10YR 4/4 when moist) weak, fine and medium crumb structure, soft when dry, very friable when moist, nonsticky and nonplastic when wet (B_2 horizons are 14 to 18 inches thick).
A^1_2	16-19 inches - Light olive gray (5Y 7/1 with common medium prominent (10YR 6/6 mottles when dry) light very find sandy loam, light olive gray (5Y 6/1 with common medium prominent 10YR 4/5 mottles when moist) massive, very hard when dry, very friable when moist, nonsticky and nonplastic when wet (two to six inches thick).
B^1_2	19-36 inches - Light olive gray (5Y 7/1 with common medium) and coarse prominent pale brown (10YR 6/3 mottles when dry) light very fine sandy loam, light olive gray (5Y 6/1 with common medium) and coarse prominent dark brown (10YR 5/3 mottles when moist) moderate medium and coarse platy structure, very hard and brittle when dry, friable when dry, nonsticky and nonplastic when wet, dark brown one to two mm thick bands between plates.
$B^1$22X	36-48 inches - Light olive gray (5Y 7/1 with common medium) and coarse pale brown (10YR 6/3 mottles when dry) light very fine sandy loam, olive gray (5Y 6/1 with common medium) and coarse prominent dark brown (10YR 5/3 mottles) when moist, weak coarse platy structure, very hard and brittle when dry, very friable when moist, nonsticky and nonplastic when wet, dark brown one to two mm thick bands between plates.
C^1_1	48-54 inches - Light olive gray (5Y 7/1 when dry) loamy very fine sand, olive gray (5Y 6/1 when moist) massive, soft when dry, very friable when moist, nonsticky and nonplastic when wet, many medium and coarse rust colored mottles.

IIC_2 54-72 inches - Loose fine and medium sands, with many medium and coarse rust colored mottles.

NOTES: The depth to the very hard and brittle horizons is 14 to 20 inches. Depth to loose sands is 48 to about 66 inches.

Texture of profile is fine sandy loam, loam, very fine sandy loam, or silt loam, all with very low clay content and a high silt and very fine sand content. A few gravels are on surface and in subsoil in places.

Chemical and Physical analysis of Type 1 shows the following following results:

(1) pH and Soluable Salts

Soluble salts were very low and should not present any germination or seedling establishment problems. Conductivity was less than 1 mmhos/cm. pH runs 7.8.

(2) Sodium Absorption Ratio (SAR)

SAR is correspondingly very low and values do not exceed 1 SAR. Crusting of soil surface from dispersion of fine material should be very minimal.

(3) Texture

Textures are fine sandy loam. This coarse texture will prevent salt accumulation and maintain normal plant development.

(4) Nitrate Nitrogen

Nitrates are very low on all depths and should not be a threat to runoff or underground water.

(5) Boron

Boron is low and should not restrict normal plant growth.

(6) Micronutrients

Chelatable zinc, iron, copper and manganese were analyzed for predicting nutrient requirement and potentially hazardous levels. There were no unusually high levels that should restrict plant growth. Zinc was exceptionally low and may have to be supplemented for seedling establishment.

Because of soluable salts, SAR micronutrients and boron are all very low, plant development and growth should not be restricted (Appendix C).

d. Soils in the Project Area

Soils in the mine adit mill site area are of the Unit 4 type. Primarily glacial till with small outcrops of bedrock. The vertical depth of the till to bedrock is approximately 60 feet with the horizontal distance to bedrock being 100+ feet. (Bingham, 1977, personal communication.)

Soils in the corridor between the mill site and the tailings pond area that will contain the road, transmission line, mill water return line, and slurry pipe line are primarily Types 4 and 2 with a small amount of Type 1. These soils are relatively deep and stable.

Soils in the tailings pond area are Types 1 and 2 on gentle to flat ground. These soils are deep sandy loam type with gravel and stones predominately below 40 inches in depth (Appendix C). The soils have a very low clay content. Drilling of wells and test holes indicate depths to bedrock are very great up to 300 feet (Woodward and Clyde, 1976-77). Analysis shows the soil to be 12 percent clay, 11 percent silt and 77 percent sand. Topsoils in this type are highly suitable for reclamation revegetation. Permeability of soils will necessitate careful design of the tailings pond and dam.

During the summer and fall of 1977, additional drillings were conducted at the mill site for foundation investigations. The work was done by Dames and Moore, engineering consultants of Denver, Colorado.

Borings were made at the location of the office-tailings thickner site and at the crusher site. Test pits were dug at the sites of the crusher, concentrator, and office thickner site. The foundation investigation work was not completed because of weather and will be continued during the summer of 1978. (Dames and Moore, 1977).

The major value of the borings to date has been to confirm the absence of adverse conditions at depth, such as exceptionally soft or weak layers, and to confirm the absence of bedrock at the boring locations.

Tentative conclusions of the incomplete study to date indicates:

a. The soils as being generally of cohesionless sands, gravels, cobbles and boulders probably of recent glacial origin.

b. Additional drilling will be necessary to establish the location of the true water table.

c. The most feasible foundation for the structures would be a conventional spread, strip and mat foundation.

d. The thickner and mill water reservoir would probably require impervous linings to control seepage.

7. Water Resources

a. Geomorphology

(1) Bull Lake Valley

Much of the Bull Lake Valley was filled by ice during the Pleistocene Age. Geologic interpretations of the glacial history of the area are based on the work of Alden (1942), Adkinson (1942) and English (1942). Alden (1953) hypothesises that ice may have filled the entire Lake Creek/ Bull River Valley to its confluence with the Clark Fork during mid-Wisconsin time (prior to 40,000 years before present). During late Wisconsin time (10,000 to 25,000 years before present), ice probably extended no further south than the southern margin of Bull Lake. Johns (1970) speculates that prior to glaciation, Bull Lake flowed south and was drained by the Bull River. The material composing this drainage divide is glacial till and glacial outwash (Alden, 1953).

The maximum depth of Bull Lake is 64 feet. Since the retreat of glacial ice, this area has been filled with sediment. Most of the filling of Bull Lake/Lake Creek Valley took place as ice receded north and blocked the drainage of the Kootenai River in what is now Montana. This lake filled the Kootenai River Valley, as well as the valleys of Lake Creek, Libby Creek and the Fisher River. This former lake drained to the south through the low pass south of Bull Lake and into glacial Lake Missoula, which once filled the lower Clark Fork Valley. Thus, the entire Bull Lake Valley was filled by a lake, and lake sediments of silt sand and gravel are found throughout the present valley.

When ice receded north of the Purcell Trench in Idaho, the Kootenai River flow was no longer blocked and glacial Lake Kootenai drained. The outwash terrace and moraine south of Bull Lake blocked Bull Lake's drainage to the south and Bull Lake began to flow to the north, forming Lake Creek. As the Kootenai River continued to downcut to the north, Lake Creek cut deeper into the valley sediments. Thus, Bull Lake is underlain by glacial till and glacial lake sediments and most of the Lake Creek Valley trough was filled by sediment during the latter part of the Pleistocene Age when the Lake Creek Valley was filled by glacial Lake Kootenai.

In the last 10,000 years, since the end of the Pleistocene, sediment deposition in Bull Lake has significantly decreased. Inspection of each stream tributary to Bull Lake was made in fall, 1977, and it appears that Ross Creek, Weasel Gulch, Emma Gulch and Stanley Creek are the major sources of sediment into Bull Lake. Each of these streams shows evidence of a high sediment transport rate composed of coarse material. Field examination of the lower section of Ross Creek indicates flood flow transport of gravel and cobbles. At the mouth of Ross Creek, a distributary delta has formed as a result of transport of sediment into Bull Lake. Gravel bars frequent the lower half mile of Ross Creek and are evidence of flood flow deposition. The size of the Ross Creek drainage areas, and the size of flood flows in Ross Creek, as well as the nature of sediment in the present Ross Creek channel, indicate that Ross Creek is the principal source of sediment to upper Bull Lake.

Field examination of Weasel Gulch and Emma Gulch indicates that both of these streams, which drain the eastern side of Mt. Vernon, transport much sediment. In October, 1977, the lower sections of both gulches were dry. Field examination of their stream beds revealed large cobble and gravel bars indicating flood flow transport and deposition. The lower section of Emma Gulch has eroded a road to about 5 feet in depth. In the lower quarter mile of Emma Gulch the channel becomes indistinct and gravel debris is found in a broad fan. Small deltas at the mouths of both gulches result from deposition into Bull Lake. Field examination of Noggle Creek and Upham Creek indicate small amounts of sediment transport. Both creeks have small channels with stable banks and small amounts of gravel in their streambeds. Flood flows probably consist mostly of suspended sediment. Payne Creek is dammed in Section 28, supplying water for houses in T29N, R33W, S29DAB. Sediment transport in Payne Creek is largely deposited in this reservoir.

Examination of the distributary area of Stanley Creek in T29N, R33W, S8D indicates that most gravel in Stanley Creek is deposited in an alluvial fan prior to reaching Bull Lake. The lower channels of Stanley Creek near Bull Lake are filled with fine muds and gravel is only infrequently encountered. A few small gravel bars were observed at the mouths of a few of the small channels leading into Bull Lake. The northern portion of Bull Lake has been partially filled over time with fine sediment from Stanley Creek.

(2) Lake Creek

An examination of Lake Creek was made in October, 1977 from its origin at Bull Lake to the upstream Lake Creek water quality sampling site (T29N, R33W, S6DDA); also examined was the area from the confluence of Lake Creek and Camp Creek to the northern edge of the proposed tailings pond, the lower sampling site on Lake Creek and all downstream bridge crossings of Lake Creek. Channel size, channel characteristics, bank stability, gravel bar deposition and log jams were observed throughout the Lake Creek system. Quantitative surveys of gravel bar characteristics were also made. These field studies reveal that (1) Lake Creek has a high sediment transport rate during spring flood and that channel widening is occurring in order to accommodate increased stream flow and sediment transport; (2) Lake Creek has the ability to transport large boulders (up to 50 cm); (3) log jams within the Lake Creek channel are creating erosion problems; and (4) Lake Creek experiences minor channel changes frequently.

Immediately north of Bull Lake, Lake Creek has stable banks, a gravel bottom and gravel bars are found at selected locations. The stream in this area has a meandering habit, and there is little evidence of active channel changes. About one-quarter mile downstream of Bull Lake, Dry Creek enters Lake Creek. In October, 1977, Dry Creek had no flow at its mouth. Because of access limitations, the mouth of Dry Creek was not examined in detail. However, Dry Creek was observed to have a gravel bed and probably supplies large sediment loads into Lake Creek at high flow. Field examination of Dry Creek's tributary, Spring Creek, at the road crossing of Highway 202, indicated a flow channel 6 feet deep and approximately 25 feet wide, filled with coarse gravel and cobbles. Much of this stream load is deposited in the lower portion of Dry Creek or is transported directly into the Lake Creek system. Downstream of Dry Creek, gravel bars increase in frequency and bank cutting is evident. Cutting of banks composed of gravel, produces additional sediment load into the Lake Creek system. In the vicinity of the upper Lake Creek sampling site, a bridge has been washed out apparently due to channel widening and high flood flows. A large depositional gravel bar is found just downstream of this site.

Downstream of the confluence of Lake Creek and Camp Creek, gravel bars are found more frequently than in upstream areas. Field examination of Camp Creek indicates high amounts of sediment transport and log debris into Lake Creek. The increase of gravel bars downstream of Camp Creek is probably a function of sediment inflow from Camp Creek. Frequent braiding of the stream channel in this section of Lake Creek is also indicative of high sediment transport rates. Log jams are also frequent in this section as are unstable banks. At several places, the surface of unvegetated gravel bars is almost equal in height to vegetated banks of the stream. This situation may be due to a recent increase in flood flow and sediment transport, which are reflected in the gravel bar but not yet reflected in channel accommodations. Although no quantitative studies were conducted, it appears that bank full stage on Lake Creek is regularly exceeded and that further channel widening will occur in the future. Erosions of banks, comprised of lake silts, glacial till, and glacial outwash supply additional sources of sediment to the Lake Creek system. Opposite the northern portion of the tailings pond (T30N, R33W, S31), gravel bars decrease in frequency and the stream appears to be fairly stable.

Examination of the Cromwell Mountain and Kootenai Falls USGS topographic maps indicate that gravel bars are found in Lake Creek immediately downstream of most major tributaries to Lake Creek. These indicate that gravel transport from tributaries into Lake Creek occurs at each of these sites. Thus, Porcupine Creek, Twin Creek, Keeler Creek, Copper Creek and Iron Creek all deliver loads of sediment into the Lake Creek system. Field examination of Lake Creek at several downstream sites indicates that gravel bars are frequent in this area. Field examination of Keeler Creek indicates that this stream transports the largest size gravel and cobbles of any stream observed in the Lake Creek system. The observed competence (ability to transport large material) of Keeler Creek indicates high sediment transport rates. Logging activities in Keeler Creek have been extensive, and significant erosion of road crossings has occurred (B. W. Wynecoop USFS, Troy, Montana, personal communication, October 1977). These activities have probably resulted in increased runoff and higher peak flows in the Keeler Creek basin and increased sediment transport rates.

The field examination of Lake Creek indicates gravel transport is common. Most fine-grained material is transported out of the system and channel changes are occurring within the width of the current low terrace area.

Table II-4 lists sampling sites and the most frequently encountered size of gravel material on exposed gravel bars. Examination of the table shows that the coarsest material is found in downstream sections of Lake Creek. This is probably a function of coarse debris delivered to Lake Creek by Keeler Creek and other tributaries in the lower portion of the stream and the increased stream gradient below the Troy Dam. The coarse load of Keeler Creek is indicated by the gravel bar sample listed on Table II-4. This data indicates that coarse debris is transported by Lake Creek and that a significant debris load is contributed by Keeler Creek.

Lake Creek has the competence to transport any material potentially released into it from mining and related activities. Because channels are already changing to accommodate increased loads, further channel widening would be expected if significant amounts of new sediment in gradient as they enter the valley floor of Lake Creek. Low gradient alluvial fans have formed at the margin of the mountain front. Channel changes in these areas have been common in the Recent geologic past.

These coarse gravel deposits have high infiltration rates and, during low flow, streamflow infiltrates into these gravel channels. Thus, streams which are flowing in upstream areas go dry in their lowest reaches. Geologically, the area has been influenced by numerous events including sedimentation, erosion, uplift and glaciation and the detailed physiography and geology are complex, particularly in the larger valleys. As a result, hydrological and groundwater conditions are complex and are not well understood.

Water quality in the area is generally excellent and this portion of Montana contains some of the best recreational and fishing waters in the entire state.

Hydrological investigations of the drainage were previously made by ASARCO Inc. and much baseline data was gathered and reported as part of these previous efforts. The additional hydrological data gathered during this investigation supplements the previous work. This additional work was begun in late May, 1977 and will continue until April, 1978. The 1977 water year was exceptional, with low to record low flows occurring in many drainages. Spring runoff was much less than what is normally a substantial runoff from the high mountains.

Table II-4 Model Size Gravel Sampled on Flood Debris Gravel Bar

	B-Axis Diameter
Lake Creek at Mouth	107 mm
Lake Creek at Lake Creek Road Bridge	107 mm
Lake Creek at Chase Cutoff Road Bridge	54 mm
Lake Creek above Porcupine Creek	107 mm
Lake Creek at upstream water quality sampling site	38 mm
Lake Creek below Camp Creek	38 mm
Lake Creek below Bull Lake	54 mm
Keeler Creek at Lake Creek Road Bridge	214 mm

Sampling and analysis of data after (Leopold, 1970).

b. Groundwater Resources

There is little groundwater information on this portion of Montana. The report by WADEVCO (1976) describes some general hydrogeological relationships and some specific groundwater systems in the proposed mining area. The U. S. Geological Survey has conducted a water quality and groundwater investigation in the Libby area to determine the impact of individual waste disposal systems on groundwater resources (USGS, 1977) and Botz (1971) described the general groundwater resources of Lincoln County.

(1) Sources

The occurrence and distribution of groundwater is closely related to both local and regional geology. Groundwater resources are greatly influenced by three geological units; Precambrian bedrock, Pleistocene glacial deposits and Recent alluvial deposits. The entire county is underlain by a thick sequence of argillite, quartzite and carbonate rocks of the Precambrian Belt Series (over 600 million years old) as well as some granitic intrusives of Jurassic and Cretaceous Age. The Belt Series has been partially metamorphosed, producing tightly compacted sediments with little or no primary porosity and permeability. Fractures, joints and faults within the Precambrian rocks allow movement of small quantities of groundwater, and generally, small quantities of groundwater can be obtained from wells drilled into the bedrock. The Pleistocene glacial history of the area is complex and involves valley glaciers, glacial lakes and outwash. This has resulted in a complex sequence of glacial deposits that vary widely in their geological and water-bearing characteristics. Wells in coarse gravels yield substantial quantities of water, whereas wells in fine-grained glacial deposits yield little or no water. It is thought that unconsolidated pre-glacial alluvium underlies glacial deposits in the Lake Creek drainage. Unconsolidated alluvial deposits of Recent Age are found along the major streams and locally can yield small to moderate quantities of groundwater. Groundwater is recharged from infiltration of rainfall and snowmelt and from infiltration of water from streams and lakes. Discharge from the groundwater systems occur as evapotranspiration, flow from springs and seeps, and flow into lakes and streams. Streamflow during the summer and fall months typically is derived from the groundwater system.

(2) Movement

Groundwater movement generally follows the slope of the land surface towards the stream bottoms. The groundwater table typically is a subdued reflection of the surface topography. Rate of groundwater movement is a function of the slope of the groundwater table (or Piezometric surface) and the permeability of the materials. There has been very little work done on movement of groundwater in the Lake Creek drainage except at the proposed tailings pond site. Underground mining in existing mine adits has encountered groundwater in fractured Precambrian rock and has drained groundwater held in faults, joints and fractures. It is thought that water drained from the adits represents a long-term accumulation and storage, and much of the water flowing from the mine adit may not be part of the short-term active hydrologic cycle. No detailed testing of this hypothesis has been made, however, very slow movement of groundwater, large underground distances, and a relatively constant outflow suggests that much of the water from the mine may be derived from storage.

(3) Use of Groundwater

There is limited groundwater use in the upper Lake Creek drainage (Table II-5). Five wells have been drilled in areas surrounding lower Bull Lake. Most homeowners around Bull Lake take water directly from the lake. Only one well around the lake is shallower than 100 feet. Since Bull Lake has a maximum depth of about 65 feet, this indicates that at most locations, adequate groundwater reserves are found in deep alluvial aquifers. Few wells have been drilled in valley fill downstream of the proposed tailings pond. Wells are generally deeper than 100 feet and conversations with local residents indicates that lake silts underlying much of the valley are poor aquifers. Wells must be completed below these lake deposits. Within two miles of the proposed tailings site, several springs are used for drinking purposes.

The closest wells to the proposed tailings pond are at Little Joe, about one-half mile from the east edge of the proposed site. The wells are 65 and 75 feet deep, each completed into sand and gravel, and reportedly yield about 20 gpm. These wells are probably upgradient from groundwater in the proposed tailing pond area.

Table II-5 Summary of Wells and Springs in the Upper Lake Creek Drainage

Location	Water Source	Depth	Drilled	Yield
30N33W20AAD	Spring			
30N33W20ADD	Well		1973	
30N33W20BAB	Spring			
30N33W20BBB	Well	160'	1975	
30N33W29DBA	Porcupine Creek			
30N33W32ACA	Spring			
30N33W32ADC1	Spring			
30N33W32ADC2	Well	75'	1974	20 gpm
30N33W32ADC3	Well	65'	1973	20 gpm
29N33W 8DDC	Spring			
29N33W17AAC	Crowell Creek			
29N33W17ABD	Well			
29N33W17ACB	Crowell Creek			
29N33W17DDC	Well	33'	1971	
29N33W20CDB	Well	110'	Before 1970	
29N33W28CCC	Well	176'	1977	Good
29N33W29BBA	Well	310'	1972	350 gpm

There are an estimated 50 wells in the valley from Bull Lake to Troy (Schultz, 1970). Depths of the wells are highly variable and range from a few tens of feet to several hundred feet. All wells in the area are used for domestic purposes with some minor usages for livestock watering and garden irrigation.

During low flow, many streams exiting the mountains, particularly east of Lake Creek, rapidly infiltrate into the ground as they approach the Lake Creek Valley. These streams typically flow small to moderate amounts of water as they approach the valley, but are dry at their confluence with Lake Creek indicating a substantial recharge to alluvial materials along the edge of the Lake Creek Valley. Ross Creek at the highway had a flow of approximately 10 cfs on October 25, 1977. Approximately one-half mile downstream towards Bull Lake, Ross Creek had infiltrated into the ground and was completely dry.

Available information indicates the bedrock contains small quantities of groundwater; the glacial deposits contain small to possibly large amounts of groundwater, and alluvium contains small to moderate quantitities of groundwater. The occurrence, volume and movement is highly variable reflecting the complex geology of the area.

(4) Mine-Mill Area

No detailed hydrogeological work has been done at the proposed mill and mine facilities, however, it is reported that test drilling at one of the proposed mine adit locations encountered unconsolidated colluvium and landslide debris, and minor amounts of groundwater. Subsurface movement of water from Spar Lake to Fairway Creek and the rapid infiltration of water from Stanley Creek into the ground indicates very permeable subsurface zones and substantial subsurface water resources. A water supply well field is proposed at the confluence of Fairway and Stanley Creeks. No test drilling was done at this location; however, the general geology of the area suggests groundwater may be available at this site to supply the required 1700 gpm.

(5) Tailings Pond

The proposed tailings pond along Lake Creek has been examined to determine groundwater conditions. Two deep test wells and 12 test holes have been drilled at the proposed pond site. A total of 25 permeability measurements in 11 test holes have been made, and water levels have been measured in test holes and test wells.

As previously described, the valley fill in the vicinity of the proposed tailings pond is a complex sequence of glacial till, glacial lake deposits, outwash deposits and alluvium. A small hill of Precambrian bedrock outcrops just east of the proposed pond site. The surficial geology of the pond site reflects the complex geology of the area and varies from fine-grained clayey silts to coarse rock and gravel. The coarser deposits tend to be nearer the edge of the valley and along the lower reaches of Camp Creek. Test wells and test holes also reflect the complex geology of the area with substantial vertical variations in materials encountered (Appendix C).

Test holes showed loose to medium dense silts, sandy silts and silty sands down to a depth of 65 feet along the proposed dam axis. (Woodward-Clyde, January, 1977). Subsurface materials on the abutments of the starter dam and within the tailings storage area are described as medium dense to dense gravelly sand, sandy gravel and cobbly gravel in the southern part of the site. Water in test holes ranged in depth from 9 feet to 65 feet, four days after drilling.

Test wells were drilled along the east side of the proposed tailing site. Test well one, after drilling, was completed in a coarse-grained zone from 167 to 283 feet deep (WADEVCO, 1976, p. 6-2). The well was then slotted in the overlying fine-grained materials, causing it to cave badly and fill with silt and clay to 190 feet. Water level in the well was reported at 75.3 feet below the casing top (WADEVCO, 1976). Water in this well on July 21, 1977, was 62.9 feet below the casing top, which is 3.4 feet lower than the water in Lake Creek opposite the well.

Test well two encountered 165 feet of very fine-grained material consisting primarily of silt and clay sized particles (WADEVCO, 1976). Coarser-grained material was encountered below 165 feet. The casing was perforated between 60 and 115 feet. Water level in the well on July 21, 1977 was 17.7 feet below the casing top. Due to the fine-grained materials encountered in the test wells, no hydraulic tests of these wells was made, thus, the hydraulic properties of the aquifer materials were not determined. Permeability tests showed great variability in permeability of materials beneath the proposed pond area. Materials vary from 8 to 8100 feet per year in permeability (Woodward-Clyde, January, 1977) and calculated values may be in error by up to two orders of magnitude from actual conditions. Along the southeastern border of the proposed tailings pond, there is a wet marshy area that has been diked and a surface water impoundment is present. The relationship of this shallow groundwater body and groundwater encountered in test holes is not certain. Water level data obtained to date from test wells and test holes, do not provide a coherent picture of the water table or piezometric surface at the pond area. This is not, however, an inadequacy of the exploration and testing, but is rather a common problem when testing low permeability, fine-grained materials. Caving, slow water movement and possible perched water zones, make it difficult to develop an accurate understanding of the water table. For purposes of this investigation, it can be assumed that seepage from the pond will move into Lake Creek. This direction of seepage is suggested by geophysical survey, water level data and the general hydrogeological setting of the area. Additional detailed data on water levels would produce a better understanding of the water system.

The most sensitive environmental condition would be infiltration of water into material underlying the proposed tailings pond and subsequent underground movement and discharge into Lake Creek. This assumed water path will be used in this report for analysis of the impact of pond seepage on Lake Creek.

c. Surface Water

Considerable water quality sampling has been done in the area. All sampling stations are shown on Figure II-1 and sampling in the area is summarized in Table II-6. Appendix F contains a description of the major surface water systems of the area and available streamflow data as well as a schematic diagram of ASARCO's proposed water system.

Water quality in the Lake Creek drainage generally is excellent. Waters are a calcium-bicarbonate type and are soft with low concentrations of dissolved minerals, metals and nutrients. Uses of water such as irrigation, and private water supplies, depends on water quality. Aquatic life is particularly dependent on water quality and changes in quality often are reflected by adjustments in organism numbers and composition. Based on statewide studies, water quality in northwestern Montana is among the highest in the state. With the exception of some local impacts due to logging, road building and subdivisions, water quality in the Lake Creek drainage is little affected by man's activities.

The goals of the water quality investigation were to (1) confirm previous water quality baseline data; (2) develop baseline data for specific stream segments that may be impacted by the ASARCO development; and (3) develop an understanding of water quality dynamics in surface water systems and potential effects of the proposed development.

All streams, lakes and other surface waters have been classified by the Montana Department of Health and Environmental Sciences. This classification, included in the Departments Water Quality Standards (MAC 16-2.14(10)S14480), prescribes the beneficial use of water in each classification, and states specific water quality criteria for these waters.

The Kootenai River and all streams in the entire Lake Creek drainage are classified B-D[1]. As defined in the Water Quality Standards, the water-use description for this classification is:

> *Water-use description: The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation,*

Table II-6 Water Quality Bureau Baseline Water Chemistry Sampling Schedule: Parameters and Dates Sampled

Station	Major Ions	Temp.,SC, and/or pH	Metals	Nutrients	Oil & Grease
North Exploratory adit discharge		05/11/76 06/26/77 07/20/77	05/11/76 06/26/77 07/20/77	06/26/77 07/20/77	07/20/77
Stanley Creek below North Exploratory adit		06/26/77 07/20/77	06/26/77 07/20/77	06/26/77 07/20/77	07/20/77
Stanley Creek below Fairway Creek	03/21/77	03/21/77 04/20/77	03/21/77 07/20/77		07/20/77
Stanley Creek at bridge near mouth		04/20/77 06/26/77 07/20/77	04/20/77 06/26/77 07/20/77	04/20/77 06/26/77 07/20/77	07/20/77
Lake Creek below Stanley Creek above prop. tailings pond		04/20/77 06/26/77	04/20/77 06/26/77 07/20/77	04/20/77 06/26/77 07/20/77	07/20/77
Lake Creek near Twin Creek above Porcupine Creek		04/19/77 06/25/77	04/19/77 06/25/77	04/19/77 06/25/77	
Keeler Creek at bridge above Lake Creek		04/20/77		04/20/77	
Lake Creek below Felix Creek	03/21/77	03/21/77	03/21/77	03/21/77	
Lake Creek at Troy		04/21/77 06/25/77	06/25/77	04/21/77 06/25/77	
Kootenai River at Troy		04/21/77 06/25/77	06/25/77	04/21/77 06/25/77	
South Exploratory adit discharge		07/20/77	07/20/77	07/20/77	07/20/77
Ross Creek at bridge near mouth			07/20/77		07/20/77

> *filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonoid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.*

Any waste waters from mining operations in Montana that discharge to surface waters in Montana must meet conditions established in the Water Quality Standards. For design purposes, water quality standards must be met only for stream flows that equal or are greater than the 7-day, 10-year low flow. This flow is the minimum consecutive 7-day average low flow that is equaled or exceeded once every 10 years.

Quality of surface water not only must meet these specific and general criteria, but also must comply with the "non-degradation" statement contained in Montana Laws Regarding Water Pollution (Title 69, Chapter 48, Section 69-4801.2(1)(c)(iii) which states:

> *The Board shall require that any state water, whose existing quality is higher than the established water standards, be maintained at that high quality unless it has affirmatively been demonstrated to the Board that a change is justifiable as a result of necessary economic social development and will not preclude present and anticipated uses of these waters.*

The intent of this statement is to prevent degradation of high quality waters in Montana. In application of the law and water quality standards to effluents, this statement is of major significance. It requires that water quality of receiving waters be kept high and not be allowed to degrade to the minimum specific criteria.

(1) Sample Sites and Program

The water quality sampling program was designed to determine baseline conditions for surface waters particularly for those parameters most likely to be impacted by the proposed mining activities.

Water quality data available at the beginning of the investigation provided a good baseline for some streams, but was limited in locations relative to expected impacts. As part of the baseline assessment investigation, ASARCO sampled 12 sites for physical parameters, major ions, metals, nutrients, coliform organisms, oil and grease, oxygen parameters (Figure II-1). The U. S. Forest Service sampled nine stations for physical properties, major ions, metals and nutrients (Figure II-1) beginning in May, 1975 and continuing to the present. The sampling frequency varied, but most stations have been sampled about seven times with sampling occurring in the spring through fall months. The Water Development Corporation (WADEVCO) sampled the two test wells at the proposed tailings pond and these waters were tested for major ions and nutrients.

An investigation of eutrophication potential of Bull Lake by Hartman (1971) examined fecal streptococcus, coliform, three types of phosphorous, pH, BOD, dissolved oxygen and five metals at a number of sites (6 to 19 depending on parameters) in Bull Lake and nearby streams. Detection limits for metals were high and nearly all tests showed metal concentrations less than the detection limits.

Data from the adits, upper Stanley Creek (the perennial segment near the proposed mine adit) and near the proposed tailings pond, were either absent or insufficient to characterize the water quality. The previous data also contained numerous inconsistancies and some parameters, including zinc, oil and grease, nutrients, phenol and dissolved solids, appeared to be erroneous for some sampling dates.

Stations and parameters sampled during this investigation are listed in Table II-6 and Table II-7. All sampling, preservation, storage and analysis was done in accordance with approved EPA techniques, or techniques from the 14th Edition of Standard Methods for Examination of Water and Waste-water.

The investigation was completed during a period of unusually low precipitation and associated streamflow.

As described in the biological section, this investigation was intense in areas of most probable impact; that is, Stanley and upper Lake Creeks, and was only cursory for other drainages and Bull and Spar Lakes. The water quality parameters examined were:

1. specific conductivity (an overall measure of total dissolved solids),

2. nutrients - phosphate and nitrate in various forms as an indicator of trophic status of the waters,

3. temperature,

4. metals - zinc, iron and copper, and

5. turbidity - measures suspended particulate matter.

Table II-7 Water Quality Bureau Biological and Surface Water Chemistry Stations

CODE	DESCRIPTION	LOCATION	ELEVATION (FT.)
NAD	ASARCO North Exploratory Adit Discharge	29N 34W 35AAB	4440
SC1	Stanley Creek below North Exploratory Adit	29N 34W 26DAC	3750
SC2	Stanley Creek where becomes intermittent	29N 23W 24CDC	3080
SC3	Stanley Creek below Fairway Creek	29N 34W 13BADA	2510
SC4	Stanley Creek at bridge near mouth	29N 33W 7DBDD	2350
LC1	Lake Creek below Stanley Creek*	29N 33W 6DDAC	2350
LC2	Lake Creek above Porcupine Creek**	30N 33W 30DAA	2245
KC1	Keeler Creek at bridge above Lake Creek	30N 33W 19CCAC	2360
LC3	Lake Creek below Felix Creek	30N 33W 5ABA	2120
LC4	Lake Creek at Troy	31N 33W 18CBBA	1880
KR1	Kootenai River at Troy	31N 33W 1DCC	1865
SAD	ASARCO South Exploratory Adit Discharge	28N 33W 6ACD	4400
RC1	Ross Creek at bridge near mouth	28N 33W 8ADA	2430
	Ross Creek near Troy, Montana (USGS)	28N 33W 8AD	2430
	Stanley Creek near Troy, Montana (USGS)	29N 33W 7DBD	2350
	Lake Creek near Troy, Montana (USGS)	30N 33W 7AD	2150

*Above proposed tailings pond.

**Also called Lake Creek near Twin Creek.

Quality is very similar in all surface waters in the drainage with only small areal or seasonal variations. The basic water quality is a direct result of the quality of precipitation with some addition of ions from rock/water interactions. Water quality in Belt Series Precambrian rocks usually is excellent and quality in this drainage is exceptionally high. Biological productivity is generally low in these cold and pure waters and the systems are poorly buffered. This means that small inputs of acid or alkaline wastes can alter pH. Similarly, wastes added to these streams usually have a greater impact than in streams with higher concentrations of dissolved minerals. These streams, thus, are sensitive to changes, and can easily be adversely impacted.

During this investigation (see Table II-7), the U. S. Geological Survey measured water quality at three sites in the drainage. These were Ross Creek near the mouth, Stanley Creek near the mouth and Lake Creek about five miles downstream from the proposed tailings pond.

Data generated by the USGS, the U. S. Forest Service, WADEVCO, Hartman, Montana Fish and Game and the Water Quality Bureau, are listed in Appendix G. From this data, sets of typical water quality data at 14 stations were selected and are shown in Table II-8.

(2) Bull Lake

Bull Lake is a long, narrow, relatively shallow lake and is the starting point of Lake Creek. Water goes into Bull Lake primarily from Ross Creek and Stanley Creek and from numerous smaller tributaries in the mountains both east and west of Bull Lake. The lake water quality generally is good; however, Bull Lake is shallow and during the summer, water temperatures in Bull Lake become high for cold water fish. Stanley Creek enters Bull Lake on the very downstream end at the point where Bull Lake is acting as a wide slow river rather than a lake. Bull Lake was sampled at the south end and near Door Skeels campground (Figure II-1) as part of the ASARCO baseline assessment and is still being sampled by ASARCO. Water quality data shows Bull Lake to be of good quality and, as is typical of other waters in the area, it is a soft calcium-bicarbonate type water, slightly alkaline, with a low concentration of dissolved minerals, nutrients and metals. The lake contains very little oxidizable organic matter and low coliform concentration. Although the concentration of nitrogen and phosphorous are not high enough to cause excessive unwanted aquatic growths, there is a relatively high production of vegetation in the north end of the lake due to its shallow depth and warmth. Waters from Bull Lake Creek, and in the late summer, warm water from Bull Lake exerts a significant influence on temperatures in upper Lake Creek.

Table II-8 TYPICAL WATER QUALITY DATA FROM SELECTED STREAMS AND LAKES IN THE LAKE CREEK DRAINAGE, LINCOLN COUNTY, MONTANA

	STATION													
PARAMETER	NAD	SC1	SC3	LC1	LC2	LC4	KR1	SAD	Lake Cr. near Troy	Stanley Cr. near Troy	Ross Cr. near Troy	Bull R. No. 12	S. End of Bull Lake	Spar Lake near campground
Sampling Agency	WQB	WQB	WQB	WQB	WQB	WQB	WQB	WQB	USGS	USGS	USGS	ASARCO	ASARCO	ASARCO
Date Sampled	6/26/77	6/26/77	3/21/77	6/26/77	6/25/77	6/25/77	6/25/77	9/30/76	4/28/77	4/28/77	4/28/77	10/16/75	16/16/75	10/16/75
Temperature (^{0}C)	5.0	9.0	5.5	18.0	15.0	15.0	12.0	6.5	6.5	5.5	6.5	8.5	13.0	11.0
Flow (cfs)	.15	2.1	-	93	87	147	3450	-	660	34	300	-	-	-
Specific Conductance (umhos/cm)	116	57	51	62	67	84	261	187	55	56	45	66	43	28
Total Dissolved Solids (mg/l)	100	-	60.	-	-	-	-	147	32	36	27	94	78	36
pH (units)	8.1	8.2	7.7	8.2	8.0	8.2	8.5	7.3	8.0	7.6	7.8	7.3	7.6	7.4
Total Suspended Solids (mg/l)	10.8	11.7	-	<11.1	<9.4	<13.0	<9.5	-	-	-	-	-	-	-
Turbidity (JTU)	0.3	0.3	-	0.6	0.4	0.7	0.8	-	15.0	0	1.0	.38NTU	.34 NTU	.33 NTU
Alkalinity (mg/l as $CaCO_3$)	60	-	27	-	-	-	109	-	23	28	18	-	-	-
Hardness, Total (mg/l)	58	-	36	-	-	-	95	-	25	31	21	-	-	-
Non Carbonate Hardness (mg/l)	-	-	-	-	-	-	-	-	2	3	3	-	-	-
Calcium (mg/l as Ca)	19.6	-	10.5	-	-	-	-	27.3	7.1	8.9	6.2	12.2	7.9	4.9
Magnesium (mg/l as Mg)	2.2	-	2.5	-	-	-	-	6.5	1.7	2.2	1.4	3.45	1.89	1.08
Sodium (mg/l as Na)	0.8	-	0.4	-	-	-	-	1.1	.7	.5	.2	.95	.58	.56
Potassium (mg/l as K)	0.38	-	0.0	-	-	-	-	0.43	.4	.2	.1	1.0	.66	.54
Bicarbonate (mg/l as HCO_3)	73	-	33	-	-	-	129	91	28	34	22	22.9	14.8	9.0
Carbonate (mg/l as CO_3)	0	-	0	-	-	-	2	0	0	0	0	0	0	0
Chloride (mg/l as Cl)	0.5	-	0.1	-	-	-	-	0	.2	.1	.3	1.25	.38	.27
Sulfate (mg/l as SO_4)	3.2	-	14.0	-	-	-	-	20.0	2.9	1.8	3.7	<1.0	<1.0	<1.0
Fluoride (mg/l as F)	<0.5	-	-	-	-	-	-	.12	.0	.0	.1	.08	.03	.056
Silicate (mg/l as SiO_2)	-	-	-	-	-	-	-	-	5.2	5.8	4.3	-	-	-
Cyanide (mg/l as CN)	-	-	-	-	-	-	-	-	.00	.00	.00	.002	<.001	<.001
Total Nitrogen (mg/l as N)	<0.10	.47	-	.49	.39	.49	.37	-	.10	.09	.38	-	-	-
Total Organic Nitrogen (mg/l as N)	-	-	-	-	-	-	-	-	.00	.00	.00	-	-	-
Total NH_3 Nitrogen (mg/l as N)	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	.00	.00	.00	-	-	-
Total Kjeldahl Nitrogen (mg/l as N)	-	-	-	-	-	-	-	-	.00	.00	.00	-	-	-
Total NO_2+NO_3 (mg/l as N)	.21	.14	-	.04	.04	.03	<.01	.45	.10	.09	.38	.01	.004	.004
Total Phosphorus (mg/l as P)	.004	.009	-	.004	.004	.004	.008	-	.00	.00	.01	-	-	-
Phosphate (mg/l as P)	.002	-	-	.001	<.001	<.001	<.001	-	-	-	-	.025	.055	.02
Sodium Adsorption Ratio	0.0	-	0.0	-	-	-	-	0.0	0.1	0.0	0.0	-	-	-
Carbon Dioxide (mg/l as CO_2)	-	-	-	-	-	-	-	-	0.4	1.4	0.6	-	-	-
Dissolved Oxygen (mg/l as O_2)	-	-	-	-	-	-	-	-	11.0	11.5	11.8	12.9	11.3	10.0
Total Coliform/100 ml	-	-	-	-	-	-	-	-	-	-	-	4	12	2
Fecal Coliform/100 ml	-	-	-	-	-	-	-	-	-	-	-	0	0	0
Phenol (mg/l)	-	-	-	-	-	-	-	-	-	-	-	<.008	<.008	<.008

Table II-8 (continued)

PARAMETER	NAD	SC1	SC3	LC1	LC2	LC4	KR1	SAD	Lake Cr. near Troy	Stanley Cr. near Troy	Ross Cr. near Troy	Bull R. No. 12	S. End of Bull Lake	Spar Lake near campground
Oil and Grease (mg/l)	-	-	-	-	-	-	-	-	-	-	-	5.9	6.0	7.7
BOD (mg/l as O_2)	-	-	-	-	-	-	-	-	-	-	-	0.9	1.3	0.8
COD (mg/l as O_2)	-	-	-	-	-	-	-	-	-	-	-	2.8	6.65	7.35
ABS (mg/l as O_2)	-	-	-	-	-	-	-	-	-	-	-	0.03	0.03	0.01
Aluminum, Diss. (mg/l as Al)	<.10	-	-	-	-	-	-	-	-	-	-	.06	<.001	<.001
Aluminum, TR (mg/l as Al)	<.10	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony, Diss. (mg/l as Sb)	-	-	-	-	-	-	-	-	-	-	-	.14	.10	.082
Arsenic, Diss. (mg/l as As)	<.001	-	-	-	-	-	-	-	.000	.000	.000	.002	<.001	<.001
Arsenic, TR (mg/l as As)	.001	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic, Total (mg/l as As)	-	-	-	-	-	-	-	-	.000	.000	.000	-	-	-
Barium, Diss. (mg/l as Ba)	-	-	-	-	-	-	-	-	-	-	-	1.52	1.04	.79
Beryllium, Diss. (mg/l as Be)	-	-	-	-	-	-	-	-	-	-	-	<.001	<.001	<.001
Boron, Diss. (mg/l as B)	-	-	-	-	-	-	-	-	.000	.000	.000	-	-	-
Cadmium, Diss. (mg/l as Cd)	<.005	-	-	-	-	-	-	-	.000	.000	.000	.009	<.001	<.001
Cadmium, TR (mg/l as Cd)	<.005	-	-	-	-	-	-	<.005	-	-	-	-	-	-
Cadmium, Total (mg/l as Cd)	-	-	-	-	-	-	-	-	<.010	<.010	<.010	-	-	-
Chromium, Diss. (mg/l as Cr)	-	-	-	-	-	-	-	-	.000	.000	.000	<.001	<.001	<.001
Chromium, Total (mg/l as Cr)	-	-	-	-	-	-	-	-	.000	.000	.000	-	-	-
Cobalt, Diss. (mg/l as Co)	-	-	-	-	-	-	-	-	-	-	-	<.001	<.001	<.001
Copper, Diss. (mg/l as Cu)	.02	.01	<.01	<.01	<.01	<.01	<.01	-	.000	.000	.000	.003	.003	.004
Copper, TR (mg/l as Cu)	.02	-	<.01	-	-	-	-	.05	-	-	-	-	-	-
Copper, Total (mg/l as Cu)	-	-	-	-	-	-	-	-	<.010	<.010	<.010	-	-	-
Iron, Diss. (mg/l as Fe)	<.01	-	<.05	-	-	-	-	-	.020	.010	.010	.27	.091	.03
Iron, TR (mg/l as Fe)	<.01	-	<.05	-	-	-	-	<.05	-	-	-	-	-	-
Iron, Total (mg/l as Fe)	-	-	-	-	-	-	-	-	.810	.010	.060	-	-	-
Lead, Diss. (mg/l as Pb)	<.05	-	-	-	-	-	-	-	.000	.000	.000	.005	.002	.009
Lead, TR (mg/l as Pb)	<.05	-	-	-	-	-	-	<.05	-	-	-	-	-	-
Lead, Total (mg/l as Pb)	-	-	-	-	-	-	-	-	<.100	<.100	<.100	-	-	-
Manganese, Diss. (mg/l as Mn)	-	-	-	-	-	-	-	-	.000	.000	.010	.008	.015	.005
Manganese, TR (mg/l as Mn)	-	-	-	-	-	-	-	.03	-	-	-	-	-	-
Manganese, Total (mg/l as Mn)	-	-	-	-	-	-	-	-	.020	.000	.010	-	-	-
Mercury, Diss. (mg/l as Hg)	<.0002	-	-	-	-	-	-	-	.0000	.0000	.0000	<.001	<.001	.002
Mercury, TR (mg/l as Hg)	<.0002	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury, Total (mg/l as Hg)	-	-	-	-	-	-	-	-	.0000	.0000	.0002	-	-	-
Molybdenum, Diss. (mg/l as Mo)	-	-	-	-	-	-	-	-	-	-	-	<.01	<.01	<.01
Selenium, Diss. (mg/l as Se)	-	-	-	-	-	-	-	-	.000	.000	.000	<.002	<.002	<.002
Selenium, Total (mg/l as Se)	-	-	-	-	-	-	-	-	.000	.000	.001	-	-	-
Silver, Diss. (mg/l as Ag)	-	-	-	-	-	-	-	-	-	-	-	<.001	<.001	<.001
Silver, TR (mg/l as Ag)	-	-	-	-	-	-	-	<.01	-	-	-	-	-	-
Tellurium, Diss. (mg/l as Te)	-	-	-	-	-	-	-	-	-	-	-	.009	.012	.02

Table II-8 (continued)

PARAMETER	NAD	SC1	SC3	LC1	LC2	LC4	KR1	SAD	Lake Cr. near Troy	Stanley Cr. near Troy	Ross C near Troy
Tin, Diss. (mg/l as Sn)	-	-	-	-	-	-	-	-	-	-	-
Titanium, Diss. (mg/l as Ti)	-	-	-	-	-	-	-	-	-	-	-
Zinc, Diss. (mg/l as Zn)	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-	.000	.000	.0
Zinc, TR (mg/l as Zn)	<.01	-	<.01	-	-	-	-	<.01	-	-	-
Zinc, Total (mg/l as Zn)	-	-	-	-	-	-	-	-	.040	.000	.0

Based on data from the baseline environmental assessment (Stearns-Roger 1975) a well-defined thermocline forms in Bull Lake and the hypolimnior becomes depleted in oxygen and has a low pH. Although the chemical quality of Bull Lake is good, the shallow depth causes warm-season problems and the cold-water fishery is impared.

(3) Spar Lake

Water quality in Spar Lake is excellent and is characterized as a soft, calcium-bicarbonate type, with very low concentrations of dissolved minerals and metals, low nutrient concentrations and turbidity, little oxidizable organics, and an alkaline pH (Table II-8 and Appendix G). There is little annual fluctuation in the lake water quality. Previous data (Appendix G) shows concentrations of lead, zinc, gas and oil, COD, phenol and copper in excess of what would be desirable in high quality waters; however, it is thought that these are analytical errors and do not accurately reflect the true water quality. On September 15, 1975, specific conductivity of this lake was measured at 32.1 umhos/cm at 25° C and total dissolved solids were 31.9 mg/1. This water is nearly equivalent to distilled water and probably is directly related to quality of precipitation.

(4) Stanley Creek

Water quality has been measured on Stanley Creek at several locations as previously described. The station below the confluence of Fairway Creek with Stanley Creek measures the quality of Fairway Creek under normal flow conditions.

The quality of Stanley Creek at all stations is very similar. The water is a soft, alkaline, calcium-bicarbonate type having a low concentration of dissolved minerals and nutrients. Substantial data has been collected on metals in this stream and at all stations the concentrations have been found to be low with a few exceptions. Zinc and lead occasionally have been reported at concentrations of environmental concern. More recent data, however, collected by the U. S. Geological Survey and the Water Quality Bureau do not confirm the previously reported levels of metals in the stream. The more recent data shows metal concentrations to be very low and acceptable for all prescribed beneficial uses of the stream. Turbidity and total suspended sediment in the stream are very low and the stream, typically was very clear with turbidity estimated to be less than 5 TU (turbidity units). During the very brief runoff season of 1977, turbidity and suspended solids showed no substantial increase over baseflow conditions. The stream appears to have very little oxidizable organic matter which is confirmed by BOD analysis (biochemical oxygen demand) reported for the stream. Chemical oxygen demand (COD) has been reported as relatively high from the same samples, creating doubt as to the validity of these analyses. The concentration of total and fecal coliform organisms is low and meets all applicable standards for water use. Previous analyses indicated that "gas and oil" were present in measurable concentrations in the stream. It is assumed that the reporting parameter should hve been oil and grease which is a standard water test. Recent tests of oil and grease in the stream system have not confirmed the previous high analyses and there is considerable doubt whether previous tests are valid.

The entire Stanley Creek drainage including its upper portion appears to contain water of excellent quality and contains no substances or conditions that have been shown to be deleterious to aquatic life.

(5) Fairway Creek

There has been no water quality sampling of the lower segment of Fairway Creek; however, water quality data for Stanley Creek are available for Sample Point 2 (ASARCO baseline data - Table II-8 and Appendix G) and from the WESTECH Station SC3 (Figure II-1). It is assumed that the ASARCO Sample Point 2 labeled Stanley Creek above Fairway Creek, is actually below the confluence of Stanley Creek. Stanley Creek at this site during normal flows is almost entirely derived from Fairway Creek, thus, the discussion of Stanley Creek quality essentially is a discussion of the quality of Fairway Creek.

Fairway Creek about one mile above Stanley Creek is dry except during spring runoff. Water quality at this location was sampled by the U. S. Forest Service (Appendix G). The stream is a soft, to moderately hard, calcium-bicarbonate type with low nutrients and metals, but has a distinctly higher specific conductivity than does Fairway Creek below the springs that are its major water source. The reason for this is unknown.

(6) Lake Creek

The quality of water in Lake Creek is uniformly excellent reflecting the flow from high quality tributaries. The water is similar in quality to its tributaries, that is, its a soft, calcium-carbonate type water with low concentrations of minerals, nutrients and metals. The stream has a high oxygen content, little oxidizable or organic matter. There is little difference in quality in Lake Creek between the upper stations and the lower station near Troy. Lake Creek throughout the entire segment is of excellent quality and there appears to be no chemical or physical condition that inhibits the use of this stream for its prescribed beneficial uses.

The stream has a very low turbidity and typically flows clear water. The only turbidity measurement which showed any appreciable turbidity was made by the U. S. Geological Survey on April 28, 1977 during an early snowmelt runoff period. Turbidity at this time was 15 JTU (Jackson Turbidity Units).

(7) Ross Creek

Ross Creek is another stream having excellent quality water, low-dissolved solids, soft, low concentrations of metals and nutrients, little oxidizable organic matter, and can be characterized as an excellent quality high-mountain stream (Table II-8 and Appendix G). Ross Creek was sampled during the ASARCO baseline environmental investigation by the U. S. Forest Service and is presently being sampled by the U. S. Geological Survey and ASARCO. Based on USGS data, water quality is excellent and there are no known problems in use of this water for all its beneficial uses. It is a soft, calcium-bicarbonate water low in nutrients and metals.

(8) Bull River

The Bull River was sampled near its headwaters by the U. S. Forest Service and Montana Fish and Game Department as part of the ASARCO environmental baseline investigation (Figure II-1). It has excellent quality water and is a soft, slightly alkaline, calcium-bicarbonate type with low concentrations of metals, nutrients and dissolved minerals (Table II-8 and Appendix G). The river contains little oxidizable organic matter; has a low concentration of coliform organisms and low turbidity. The Bull River is a good cold-water fisher and an important recreation resource.

(9) Kootenai River

The Kootenai River, originating in Canada, is impounded by the recently completed Libby Dam. There has been extensive water quality data collected on the Kootenai River and in Lake Koocanusa. The Kootenai River below Libby Dam is fertile (abundant nutrients) but has excellent quality water, supports an excellent cold-water fishery and is an important recreation resource. Generally, water in the Kootenai is a calcium-bicarbonate type, moderately hard, with an alkaline pH, little oxidizable organic matter and low concentrations of dissolved minerals and metals. Typical quality of the river is shown in Table II-8. Although the Kootenai River quality is generally good the stream system has some significant problems including nitrogen supersaturation problems causing fish kills to at least 10 miles below Libby Dam (Cauce and Huston 1973) and industrial discharge of phosphorous in Canada (Nunnullee and Botz 1974) that create a nutrient rich environment in Lake Koocanusa and the river.

The phosphorous concentration in the stream varies with time, but generally is below 0.05 mg/1 (as P) and the predominant type of phosphorous is orthophosphate. Nitrogen is predominently present as nitrate and generally is less than 0.1 mg/1. These concentrations of nitrogen and phosphorous in the river should cause the river to retain its oligotrophic character and should not lead to growth of unwanted algae or aquatic plants. Turbidity in the river is very low in response to the settling of suspended material in Lake Koocanusa.

(10) North Adit

Water from the ASARCO north adit has been sampled a number of times (Appendix G) and a typical analysis is shown in Table II-8. This water is a calcium-bicarbonate type water. It is soft and contains a low concentration of total dissolved solids. The water has alkaline pH averaging and has a moderate buffering capacity due to the presence of the bicarbonate ion. Of particular interest in the adit water is the concentration of metals. Sampling has shown the adit water to have a low concentration of metals. Past sampling results have indicated some metals in the water including copper, zinc, lead and mercury. The moderately high concentrations observed in past testing were not confirmed in this investigation either by the Water Quality Bureau or the U. S. Geological Survey. Testing for metals is difficult and the discrepancy may have been caused by different analytical or sampling techniques. Nutrient concentrations in the adit water including nitrate and phosphate are low. A more complete discussion of the nutrients from the mine area is given in Section B. 1. c. (1).

Water from the adit is of a surprisingly high quality and does not have the character of acid mine drainage. The mineralogy of the host rocks and the type minerals being mined apparently do not produce acid mine water. Water exiting from the north adit and from the south adit should be representative of water quality that will be encountered in additional mining of the ore body.

An estimate of water quality to be encountered in the north adit also was made by ASARCO (MPDES application to Water Quality Bureau dated January 18, 1978) ASARCO states:

> *The quality of water presently being discharged from the ore body is comparable to that in the existing environment. It is not likely water will be encountered that will vary significantly in pH or metal concentration from that being presently discharged, with the exception that mechanized mining equipment and explosives will increase the concentrations of nitrates, suspended solids and oil and grease.*

Specific limitations in the Department of Health and Environmental Sciences proposed MPDES permit for oil and grease, metals, nutrients and suspended solids are given in Appendix H.

Present water quality from the adit is substantially better than that shown in the ASARCO MPDES permit application. There is considerable doubt that the quality would deteriorate and be as poor as indicated in the MPDES permit application. Past water quality data have not shown such high metal concentrations and there is little reason to suspect such concentrations will be encountered during the mine operation.

(11) South Adit

A small quantity of water exits the ASARCO south exploratory adit. This water has been previously sampled by the U. S. Forest Service and as part of the ASARCO baseline investigation. Results of this sampling (Table II-8 and Appendix G) shows these waters to have relatively good quality. The water is moderately hard, calcium-bicarbonate type with slightly alkaline pH, moderately low concentrations of dissolved minerals, low concentrations of metals and little oxidizable matter. The adit water is somewhat harder and contains more dissolved minerals than most streams in the area, but is still of good quality. Moderate concentrations of zinc and copper were reported for water from this adit, but were not confirmed during this investigation.

(12) Other Streams

No attempt was made to do detailed water quality testing on all streams in the Lake Creek drainage. In October, 1977, samples were taken from a number of streams for measurement of specific conductivity. In addition, there are data available for several other streams including Keeler Creek, Weasel Gulch, Hiatt and Whoopie Creeks. Quality is very similar to those streams previously described. Keeler Creek, a major tributary to Lake Creek, has been sampled by the Fish and Game Department and the U. S. Forest Service. This stream has excellent quality, very low dissolved solids, and low concentrations of metals and nutrients. Its quality is similar to distilled water and probably is directly related to chemistry of precipitation in the drainage.

B. Biological

1. Flora

a. Regional Communities

The study area lies in northwestern Montana and is typical of the vegetation growing in the area. Northwest Montana is under the influence of warm Pacific Maritime air, resulting in mild temperatures, cloudy days and abundant moisture. The vegetation is classed as temperate forest--specifically as L-DF forest type (Forestry Handbook, 1961). This forest type contains a large variety of native coniferous species as well as deciduous cottonwood and aspen. The combination of complex weather patterns, landforms and soils has produced an interesting mosaic within the area.

Along the Lake Creek Valley giant cottonwood grow along with spruce and alpine fir in the cooler spots. Occasional white pine and larch grow from the banks of the several streams in the area. The bottoms of the higher drainages support large cedar and hemlock, sometimes shading a tangle of ferns and devils club. The midslope elevations support stands of larch, Douglas-fir and white pine. Pure lodgepole stands grow in several locations in the area. On the higher south and west slopes old burns are carpeted by bear grass and low huckleberry brush with alder growing on the moist north and east slopes.

At all elevations, flowering plants are blooming through the spring and summer seasons. An incomplete wildflower collection made in the Cabinets during summer 1976 includes over 130 different plants.

Figure II-3. Forest Habitat types occurring on the ASARCO study area.

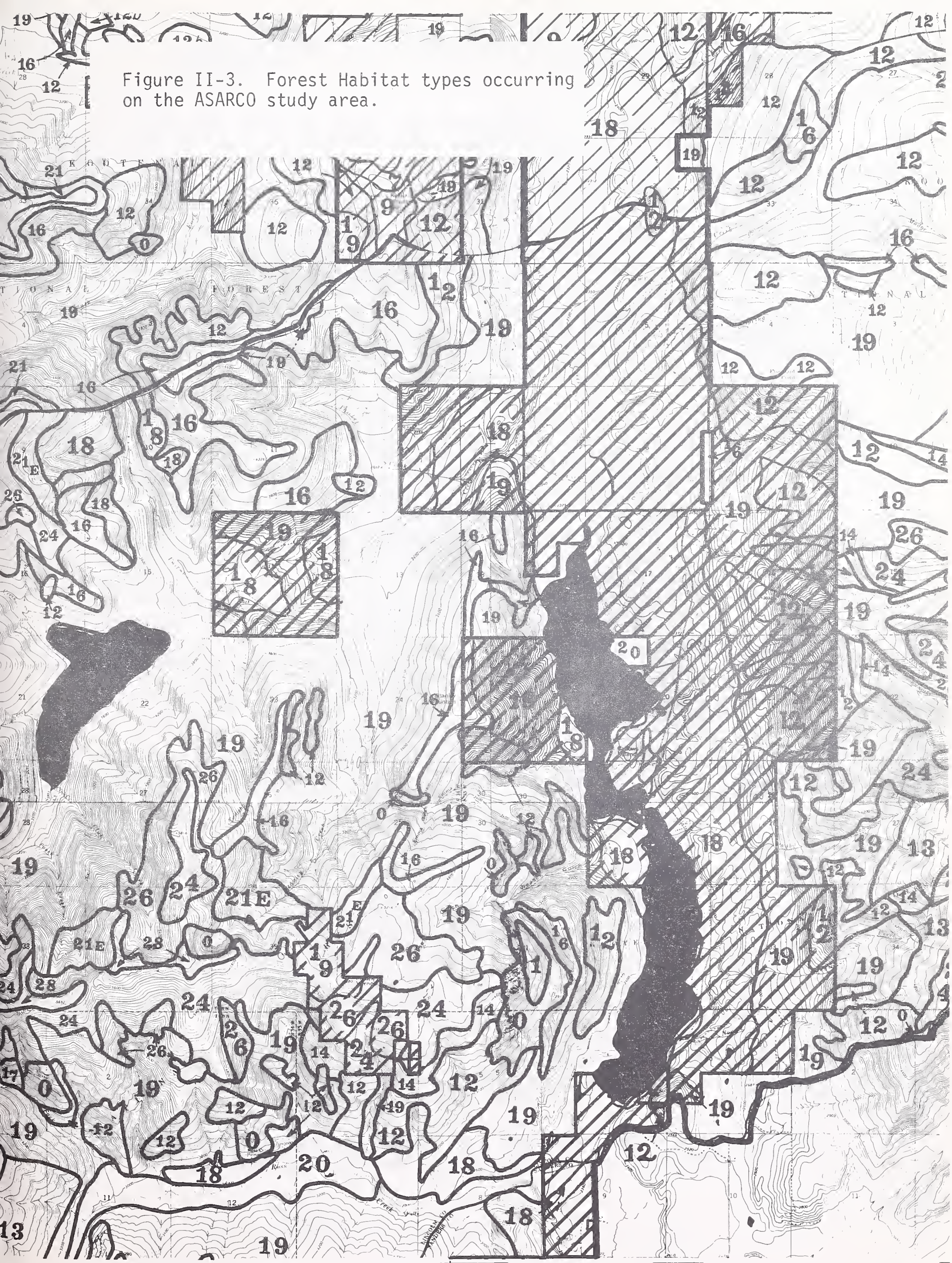


Table II-9 PRELIMINARY FOREST HABITAT TYPE CLASSIFICATION

Habitat Types and Phases	Common Names
0. Rock in place	
1. PP and/or DF/Scree	Ponderosa pine and/or Douglas-fir scree
A. Pinus Ponderosa Climax Series	
2. PP/AGSP	Ponderosa pine/bluebunch wheatgrass
3. PP/FEID	Ponderosa pine/Idaho fescue
4. PP/PUTR	Ponderosa pine/bitterbrush
5. PP/SYAL	Ponderosa pine/snowberry
6. PP/CARU	Ponderosa pine/pinegrass
B. Pseudotsuga Menziesii Climax Series	
7. DF/AGSP	Douglas-fir/bluebunch wheatgrass
8. DF/CARU	Douglas-fir/pinegrass
9. DF/ARUV	Douglas-fir/kinnikinnick
10. DF/VACA	Douglas-fir/dwarf huckleberry
11. DF/SYAL	Douglas-fir/snowberry
**a. AGSP phases	Douglas-fir/snowberry-bluebunch wheatgrass phase
12. DF/PHMA	Douglas-fir/ninebark
**a. ARUV phase	Douglas-fir/ninebark-kinnikinnick phase
13. DF/LIBO	Douglas-fir/twinflower
**a. CARU phase	Douglas-fir/twinflower-pinegrass phase
14. DF/XETE	Douglas-fir/beargrass
C. Picea Climax Series	
15. S/LIBO	Spruce/twinflower
D. Abies Grandis Climax	
16. GF/CLUN	Grand fir/queen cup beadlily
17. GF/XETE	Grand fir/beargrass
E. Tsuga Heterphylla and/or Thuja Plicata Climax Series	
18. WRC/CLUN	Western redcedar/queen cup beadlily
19. WH/CLUN	Western hemlock/queen cup beadlily
20. WH/OPHO	Western hemlock/devil's club
F. Abies Lasiocarpa (+Tsuga Mertensiana) Climax Series	
21. AF/CLUN	Subalpine fir/queen cup beadlily
**a. MEFE phase	Subalpine fir/queen cup beadlily - menziesia phase
22. AF/OPHO	Subalpine fir/devil's club
23. AF/VASC	Subalpine fir/grouse whortleberry
24. AF/XETE	Subalpine fir/beargrass
25. MH/XETE	Mountain hemlock/beargrass
26. AF/MEFE	Subalpine fir/menziesia
27. MH/MEFE	Mountain hemlock/menziesia
28. AF/LUHI	Subalpine fir/woodrush
G. Timberline Climax Series	
29. WBP-AF	Whitebark pine-subalpine fir
30. AL-AF	Alpine larch-subalpine fir

**Problem phases for management that should be mapped and recognized as distinct from the pure phases for these habitat types.

Fires have historically swept through most of the Planning Unit, much like the rest of the forest. Fires in the late 1800s and again early in this century have formed striking vegetative patterns in some areas where the differences in tree species and sizes can be seen. Those areas that were missed by these repeated fires in the last 200 years or so, are now supporting stands of larger, often mature timber. An example of this is the Ross Creek Cedars, which are many hundreds of years old. Other areas of older trees are scattered throughout the Unit, particularly in high basins and wet north slopes.

b. Habitat Types

All land areas potentially capable of producing similar plant communities at climax may be classified as the same habitat type (Daubenmire 1968b). The climax plant community, because it is the end result of plant succession, reflects the most meaningful integration of the environmental factors affecting vegetation. Thus, each habitat type represents a relatively narrow segment of environmental variation and delineates a certain potential for vegetative development. One habitat type may support a variety of disturbance-induced, or seral, plant communities, but the vegetative succession will ultimately produce similar plant communities at climax throughout the type.

The main advantage of habitat types in forest management is that they provide a permanent and ecologically-based system of land stratification. Each habitat type encompasses a certain amount of environmental variation, but the variation within a habitat type should be less than that between types. In addition, habitat types provide a classification of climax plant communities. Plant succession should be generally predictable for each habitat type, and similar responses to management treatments can be expected on units of land within the same type. The habitat types for the project area are shown in Figure II-3 a key to the habitat types occurring in the proposed project area is contained in Table II-9.

c. Aquatic Studies

(1) Algal Nutrients

Eutrophication is a condition of excessive algal growth resulting from a cultural increase in concentration of one or more nutrients that otherwise limit growth at the lower concentrations naturally occurring in most waters. Two critical nutrients that are generally in short supply in the environment and over which man has some control in terms of total input, are nitrogen and phosphorus. The allowable limits of nitrogen and phosphorus in flowing waters are discussed below (Klarich 1976).

> *Specific criteria describing the critical levels of nitrogen and phosphorus necessary to promote nuisance algal blooms have not been definitely established due to the complexity of relationships between these two constituents and the remaining components of an ecosystem (EPA, 1972). Federal surveys have indicated that 48 percent of the aquatic sites sampled across the nation had phosphorus concentrations greater than 0.05 mg/l (Gunnerson, 1966). In most uncontaminated lakes, phosphorus has been found in the range of 0.01 to 0.03 mg/l although higher values have been obtained in some nonpolluted cases (Salvato, 1958). In addition, phosphorus levels exceeding 0.2 mg/l have produced no problems in some potable supplies (EPA, 1972). Reviewing this information, the Environmental Protection Agency has suggested that total phosphorus in concentrations less than 0.05 mg/l would probably restrict nuisance plant growths in flowing waters (EPA, 1972). In contrast, much higher concentrations of inorganic nitrogen are necessary to initiate algal blooms; various studies have indicated that excessive growths of plants are avoided at nitrogen concentrations less than 0.35 mg/l (Muller, 1953 and Mackenthun, 1969). These two values then--0.05 mg/l for phosphorus and 0.35 mg/l for nitrogen--can serve as first order approximations of critical nutrient levels. Water with both phosphorus and nitrogen exceeding these respective levels can be judged as potentially eutrophic.*

These recommended limits--0.05 mg/l total phosphorus and 0.35 mg/l total soluable inorganic nitrogen (TSIN)--are compared in Table II-10 with maximum nutrient concentrations measured by the Montana Department of Health Chemistry Laboratory for waters of the Lake Creek drainage.

On review of the data contained in Table II-10, three statements can be made regarding nitrogen and phosphorus in the Lake Creek drainage:

TABLE II-10 Maximum concentrations of nitrogen and phosphorus species (mg/l) at the Water Quality Bureau sampling stations.

	NO_3+NO_2-N	NH_3-N	TSIN*	%***	PO_4-P	Total P	%***
NAD	0.25	0.01	0.25	77%	0.002	0.004	8%
SC1	0.36	0.01	0.36	103%	0.004	0.009	18%
SC3	0.11	0.01	0.11	31%	0.001	0.001	2%
SC4	0.13	0.01	0.14	40%	0.004	0.004	8%
LC1	0.10	0.01	0.11	31%	0.003	0.005	10%
LC2	0.13	0.02	0.15	43%	0.002	0.006	12%
KC1**	0.11	0.01	0.11	31%	----	0.002	4%
LC3**	0.04	0.01	0.04	11%	0.006	----	
LC4	0.12	0.01	0.13	37%	0.001	0.004	8%
KR1	0.13	0.01	0.13	37%	0.005	0.008	16%

* TSIN = Total Soluable Inorganic Nitrogen

** Only one nutrient sample collected at these stations

*** Total nitrogen and phosphorus concentrations as a percent of critical levels estimated to be necessary for the development of nuisance plant growths and algal blooms (0.35 mg/l N and 0.05 mg/l P).

1) Only one of the TSIN values and none of the total P values measured during 1977 and 1978 by the Water Quality Bureau exceed the recommended maximum limits for these parameters in flowing waters.

2) Of the two critical nutrients, TSIN is consistently closer to its eutrophication threshold level.

3) The highest TSIN values were measured in water discharged from the existing North Exploratory Adit and in upper Stanley Creek below the adit.

The generally low N and P levels in these streams suggest that nuisance algal growths, depressed dissolved oxygen levels, and water taste and odor are not problems at present. The higher concentrations of TSIN relative to the recommended maxima suggest that phosphorus might be limiting to algal growth in these waters. (This assumption is at best only partially correct as will be discussed in the following section on algal assays.) The high TSIN values for the North Adit discharge and upper Stanley Creek are probably a function of the blasting compounds used in the excavation process and do not reflect natural baseline water quality conditions in the drainage.

(2) Algal Assays

Algal assays were performed by the Montana Department of Health Chemistry Laboratory on waters of the Lake Creek drainage following "bottle test" procedures outlined by the Environmental Protection Agency (1971). Briefly, the algal assay is based on Liebig's law of the minimum, which states that "growth is limited by the substance that is present in minimal quantity with respect to the needs of the organism." Bottle algal assays may be used: 1) to identify algal growth-limiting nutrients; 2) to determine biologically the availability of algal growth-limiting nutrients; and 3) to quantify the biological response to changes in concentrations of algal growth-limiting nutrients. These measurements are made by adding a selected test algae -- Selenastrum capricornutum in this case--to the test water and determining algal growth at appropriate intervals. By addition of a complexing or chelating agent (EDTA), the test may also be used to determine whether or not various compounds or water samples are toxic or inhibitory to algae (EPA, 1971).

Algal assays were run on water samples collected from Stanley Creek, Lake Creek and the Kootenai River in April, May and July, 1977 and from Stanley Creek in February, 1978 (see Table II-11). Water

TABLE II-11 Water Quality Bureau baseline biological sampling schedule: Parameters and dates sampled. All dates 1977, except 1978 as specified.

Station	Algal Nutrients	Periphyton	Macro-Invertebrates	Chlorophyll-Biomass Accrual	Algal Assay	In-Situ Fish Bioassay
NAD	6-26; 7-20	7-19; 10-20				10-18 to 10-21
SC1	6-26; 2-9-78	7-19; 2-9-78				10-18 to 10-21
SC2		7-19				
SC3	4-29; 10-20; 2-9-78	3-21; 7-20; 10-20	3-21; 7-20; 10-20; 2-9-78	3-21 to 4-20; 10-6 to 10-20	7-20; 10-20; 2-9-78	10-18 to 10-21
SC4	4-20; 4-29; 5-25; 6-26; 7-20; 2-10-78	4-20	4-20	4-20 to 5-13; 7-8 to 7-20	4-20; 5-25	
LC1	4-20; 6-26; 7-20; 10-20; 2-10-78	4-20; 7-20; 10-20; 2-10-78	4-20; 7-20; 10-20; 2-10-78	7-8 to 7-22; 10-6 to 10-20	4-20; 7-20; 10-20	
LC2	4-19; 5-4; 6-25; 7-21 10-20; 2-10-78	4-19; 7-20; 10-20; 2-10-78	4-19; 7-20; 10-20; 2-10-78	7-8 to 7-20; 10-6 to 10-20	4-19; 7-20; 10-20	10-18 to 10-21
KC1	4-20	4-20				
LC3	3-21	3-21	3-21	3-21 to 4-20		
LC4	4-21; 6-25; 7-21; 2-11-78	4-21				
KR1	4-21; 6-25; 7-21	4-21			4-21; 7-21	
RC1		7-21				

samples collected in October, 1977 have not been assayed, but they have been frozen should the need for analysis arise in the future. Algal assay results are presented in Appendix I.

Water samples collected in April were spiked with 0.033 mg/1 P, 0.5 mg/1 N, 0.033 mg/1 P + 0.5 mg/1 N, EDTA, 0.033 mg/1 P+ 0.5 mg/1 N + EDTA and 0.033 mg/1 P + 0.5 mg/1 N + micronutrients. The responses, in terms of dry weight maximum yield of algal cells, were fairly consistent from stream to stream. Generally, the results might be summarized as follows: 1) no significant increase in yield with solitary additions of P, N and EDTA; 2) a modest increase in yield with the addition of P and N together; 3) a somewhat higher increase in yield over (2) with the addition of P, N and EDTA together; and 4) the highest yield of all with the addition of P, N and micronutrients together. In only four cases, three in the Kootenai River, did yield come within 20 percent of theoretical maximum yield, which is the principal criterion for testing the statistical significance of the results.

For water samples collected in May and July, 1977, only two treatments were considered: 1) 0.033 mg/1 P + 0.5 mg/1 N; and 2) 0.033 mg/1 P + 0.5 mg/1 N + micronutrients. Again, the results were consistent from stream to stream. The addition of N and P together resulted in a modest increase in yield over the control and the addition of N, P and micronutrients together generally doubled or tripled the yield over that achieved with only N plus P. Only two yields were statistically significant, this time both controls; even with N + P + micronutrients, yields did not approach the theoretical maxima.

On review of these results, a number of observations can be made regarding nutrient limitations and algal growth inhibitors in waters of the Lake Creek drainage:

1) Phosphorus and then nitrogen both limit algal growth at natural background micronutrient levels.

2) When excess phosphorus and nitrogen are supplied, one or more micronutrients appear to be limiting.

3) When N, P and micronutrients are all available in excess, production is still limited by some other element(s), possibly carbon (Klarich, 1977).

4) There are no metallic elements that are toxic or inhibitory to algal growth.

Waters of the Lake Creek drainage are relatively soft and unenriched by Montana standards; nutrients, common ions, alkalinity and trace elements are all generally well below average concentrations for the state (Botz and Pedersen, 1976). It is understandable then how a number of elements might be limiting algal growth in such a chemically austere environment. Nevertheless, a number of questions remain to be answered:

1) Given sufficient N and P, which micronutrient(s) is (are) limiting? (Of the trace metals commonly required for biological functions--B, Mn, Zn, Co, Cu, Mo, Fe--the two most likely to be limiting are manganese and iron.)

2) Is carbon limiting? And if it is, at what levels of N, P and limiting micronutrients does carbon become limiting?

3) What effect will the addition of mine waters have on the algal growth potential of Stanley Creek and Lake Creek?

For water samples collected in February, 1978, five treatments were applied: 1) 1.0 mg/1 EDTA: 2) 0.1 mg/1 P + 1.0 mg/1 N; 3) 0.1 mg/1 P + 1.0 mg/1 N + 1.0 mg/1 EDTA; 4) 0.1 mg/1 N + micronutrients; and 5) 0.1 mg/1 P + 1.0 mg/1 N + micronutrients + 1.0 mg/1 $NaHCO_3$. For each treatment, pH was measured at the beginning and at the end of the assay.

The combined N and P spike and the combined nutrient spike plus micronutrients both resulted in yields that are within 20 percent of the theoretical maximum. This confirms the original observation that P and N are limiting. Phosphorus is in shorter supply than nitrogen relative to the biological requirements for these elements. Consequently, P is probably the first to become limiting. The fact that micronutrients did not result in a significant increase in yield over that achieved with a combined nutrient spike indicates that micronutrients were not limiting in February, 1978.

The addition of EDTA to the control and to the combined nutrient spike did not produce yields significantly greater than the control. This again confirms that there are no metals present at toxic levels. Inhibition of the combined nutrient spike by EDTA probably resulted from the complexing and unavailability of essential micronutrients.

The addition of $NaHCO_3$ to the combined nutrient spike plus micronutrients actually inhibited yield. Values for pH at the end of the assay ranged from 7.3 to 7.6 and did not deviate significantly from the value recorded initially (7.7). These results indicate that Stanley Creek waters are sufficiently buffered and that carbon is not limiting under assay conditions. Because of the availability of carbon from CO_2 in the atmosphere, carbon also should not be limiting in the stream.

When micronutrients are limiting, determination of the specific limiting element or elements could be accomplished by the process of deduction. The effect of mine waters on algal growth potential in Stanley Creek and Lake Creek may be approximated by adding selected proportions of North Adit discharge water to water from Lake and Stanley Creeks and measuring growth response; this can be accomplished once the adit becomes accessible this spring. Algal assays should be included in a biological program to monitor the impacts of the ASARCO development on water quality in the drainage (see section on proposed biological monitoring program).

(3) Chlorophyll/Biomass Accrual

The steep gradient and coarse substrate of streams in the Lake Creek drainage discourage the establishment of large aquatic plants (macrophytes), and the relatively small volume of very turbulent water also does not allow the development of a viable plankton community. This leaves the periphyton or *Aufwuchs* as the only significant plant community in these streams (see the following section). Therefore, the rate of periphyton growth provides an index to the productivity of these flowing water ecosystems. This rate can be approximated by measuring rates of chlorophyll and biomass accrual on artificial substrates incubated in the streams. Such measurements provide an estimate of net primary production.

Standard 25 mm x 75 mm glass microscope slides were placed vertically into plastic slide cartridges produced by Design Alliance, Inc., Cincinnati, Ohio. The cartridges, each with eight slides in place, were then attached to cement building blocks, which were then placed on the bottom of the stream so that the top edge of the slides was less than six inches from the water surface. An attempt was made to place the cartridges in a position of intermediate current velocity, i.e., not in extremely slow current or slack water where diffusion might be difficult, nor in current so swift as to cause scouring. An effort was also made to avoid areas that would be in shade for much of the day.

Exposure periods ranged from 12 to 30 days. Following exposure, four slides were steeped in 90 percent (V/V) aqueous acetone for chlorophyll analysis and the remaining four were placed in a jar containing distilled water and preserved with five drops of Lugol's solution for biomass analysis. The slides were refrigerated in the dark prior to chlorophyll and biomass measurements, which were performed following procedures outlined by the APHA (1975).

The per-unit-area mass of four different pigments was determined: chlorophyll *a*, chlorophyll *b*, chlorophyll *c* and carotenoids. In addition, the relative amount of biologically inactive green pigment (pheophytin) was estimated by the chlorophyll/pheophytin ratio. This ratio is an index of the physiological condition of the periphyton algae; if the ratio is at or near 1.70, the algae contain little if any pheophytin and are in excellent condition; if the ratio is at or near 1.00, pheophytin predominates and the algae are probably in poor condition (APHA, 1975). Also calculated was the mass ratio of biomass to chlorophyll, i.e., the autotrophic index (AI) (Weber and McFarland, 1969), which reflects the relative contribution to the periphyton community of heterotrophic (nonphotosynthetic) and autotrophic (photosynthetic) organisms; the autotrophic index increases as heterotrophic organisms (animals) increase in importance. Normal AI values range from 50 to 200; larger AI values indicate water that is organically enriched (APHA, 1975).

Phytopigment and biomass accrual data from Lake Creek and Stanley Creek are presented in Table II-12. The distribution of algal pigments, particularly the preponderance of carotenoids, suggests that diatoms comprised the major portion of the periphyton flora, which indeed they did (see the following section). Excluding the three samples that exceeded maximum storage time, the average chlorophyll/pheophytin ratio was 1.24, or about one-third the distance from 1.00 (poor condition) to 1.70 (excellent condition). Thus, the physiological condition of the periphyton algae on the slides might be rated "fair".

Mean chlorophyll a accrual was 0.13 mg m^{-2} day^{-1} in Stanley Creek and 0.14 mg m^{-2} day^{-1} in Lake Creek. (These values probably underestimate the actual chlorophyll a accrual in these streams for two reasons: 1) they include values for samples that exceeded maximum recommended storage time; and 2) they were measured with a spectrophotometer having a band width (8 nm) exceeding that recommended for reading chlorophyll absorbance (0.5 to 2 nm). Even with these limitations, the actual chlorophyll content is probably not more than 25 percent greater than the measured values in Table II-12). In comparison, Klarich (1976) reviewed extreme and mean chlorophyll a accrual rates for a variety of streams in Montana (all values in mg m^{-2} day^{-1}): Yellowstone River at East Bridge (Billings)--4.76; Yellowstone River below Yegen Drain (Billings)--7.26; Yellowstone River at Huntley--10.82; Yellowstone River at Laurel--0.76; Yellowstone River at Duck Creek (above Billings)--3.01; Clark's Fork (of the Yellowstone) River near mouth--1.76; Madison River near Madison Junction (YNP)--0.5; Madison River near West Yellowstone--0.05; Tongue River--0.3; East Poplar River--0.09 to 0.19; Middle Fork Poplar River--0.11 to 0.26; West Fork Poplar River--0.48 to 0.61; and mainstem Poplar River--0.14 to 0.70. Bahls (1971) reported a mean chlorophyll a accrual rate of 2.67 mg m^{-2} day^{-1} for the East Gallatin River near Bozeman. Of these, the only flowing water in Montana that is clearly less productive than either Stanley Creek or Lake Creek in terms of chlorophyll a accrual, is the Madison River at West Yellowstone. However, the Madison at this location also supports a luxuriant community of macrophytes, which is probably where most primary production occurs. Based on these comparisons, both Stanley Creek and Lake Creek are relatively unproductive and extremely oligotrophic.

Mean biomass accrual was 115 mg m^{-2} day^{-1} in Stanley Creek and 102 mg m^{-2} day^{-1} in Lake Creek. These values compare to a mean biomass accrual rate of 490 mg m^{-2} day^{-1} in the East Gallatin River near Bozeman (Bahls, 1971), extreme values of 50 and 730 mg m^{-2} day^{-1} in the Yellowstone River above and below Billings, respectively (Klarich, 1976), and values taken from the literature (Odum, 1959) for some less productive ecosystems such as the open ocean--500 mg m^{-2} day^{-1}, oligotrophic lakes--700 mg m^{-2} day^{-1}, and bog lakes--300 mg m^{-2} day^{-1}. Whittaker (1970) reports that streams have a normal range of biomass production between 300 and 4,100 mg m^{-2} day^{-1}; all biomass accrual values for both Stanley Creek and Lake Creek fell below the low end of this range. This substantiates the prior statement that these waters are relatively unproductive and extremely oligotrophic.

Table II-12 Phytopigment and biomass accrual on artificial substrates in Stanley Creek and Lake Creek. All mass values in mg/m^2 (1977)

				PHYTOPIGMENTS						BIOMASS			
STATION	EXPOSURE PERIOD	NO. DAYS	REPLICATE NO.	CHLOROPHYLL a	CHL. a DAY	CHLOROPHYLL/ PHEOPHYTIN RATIO	CHLOROPHYLL b	CHLOROPHYLL c	CAROTENOIDS	DRY WEIGHT	BIOMASS	BIOMASS DAY	AUTOTROPHIC INDEX
SC3	03/21 to 4/20	30		11.32	0.38		0.48	4.21	13.56	8613	2253	75.1	199
	10/06 to 10/20	14		0.47	0.03	1.27	0.04	0.25	3.12		707	50.5	1504
SC4	04/20 to 05/13	23									5653	245.8	
	07/08*		1	0.48	0.04	1.47	0.12	0.48	1.79				2250
	to 07/20	12	2	0.66	0.06	1.38	0.05	0.29	2.83	114967	1080	90.0	1636
LC1	07/08* to 07/22	14		2.45	0.18	0.81	0.24	0.48	9.00	103266	2347	167.6	958
	10/06 to 10/20	14		1.43	0.10	1.24	0.08	0.39	9.09		1007	71.9	704
LC2	07/08* to 07/20	12		0.34	0.03	0.50			3.67	116933	1613	134.4	4744
	10/20	14		0.95	0.07	1.22			6.36		700	50.0	737
LC3			1	7.68	0.26		0.60	2.08	9.12	26360	3160	105.3	411
	03/21 to		2	4.95	0.17		0.54	1.27	6.61	34960	2680	89.3	541
	04/20	30	3	4.12	0.14		0.45	0.98	5.89	38333	2920	97.3	709

*Samples collected for these dates exceeded the maximum recommended storage time; phytopigment and autotrophic index data for these dates are questionable.

The autotrophic index (AI) values in Table II-12 are unusually high for streams of such low productivity and with no apparent cultural enrichment. Excluding the samples with question-able chlorophyll data, the mean AI value was 852 for Stanley Creek (from two values of 199 and 1504) and 620 for Lake Creek. A number of factors may account for these abnormally high values, aside from the possibility of underestimating chlorophyll a by using a broad-band spectrophotometer as discussed previously. First, the AI of Lake Creek might be naturally high because of the nature of its source. A lake such as Bull Lake might contribute a considerable amount of preformed nonphotosynthetic organic matter (e.g., zooplankton and seston) to Lake Creek, which would tend to raise the AI. Second, the introduction of terrestrial plant and animal debris might also raise the instream AI if such introduction are significantly greater than instream production. Third, the very low chlorophyll concentrations might fall below that level required for precise measurement. Fourth, chlorophyll and biomass measurements for calculating AI were performed on separate slides, which may have varied in the amount of periphyton accrued and thereby introduced error into the AI calculations. And fifth, the Lugol's solution used to preserve the biomass samples may have added to the measured biomass value.

To test the last three possibilities, a substantial amount of periphyton material was collected from natural substrates in backwater areas at SC3, LC1 and LC2 on October 20, 1977. In this case, chlorophyll and biomass measurements were made on the same material and sufficient material was used to preclude the possibility of imprecise chlorophyll readings. Also, no Lugol's was added. AI values along with chlorophyll/pheophytin ratios for these collections are listed in Table II-13. AI values were well above the 200 level considered maximum for unpolluted waters; even assuming a 25 percent underestimation of chlorophyll and adjusting the chlorophyll a measurement accordingly (APHA, 1975), AI values were still well above 200 (Table II-13). Consequently, Lake Creek and Stanley Creek must receive considerable organic enrichment from external sources: from adjacent terrestrial communities; from Bull Lake, in the case of Lake Creek; or from a combination of these sources.

The average chlorophyll content in algal cultures and other relatively pure algal material is assumed to be about 1.5 percent on a dry weight basis resulting in a mean autotrophic index of 67 (Weber and McFarland, 1969). The adjusted autotrophic index values at SC3, LC1 and LC2 were 532, 375 and 376, respectively (Table II-13). The autotrophic fraction of the periphyton at these stations is estimated by the following ratios:

67/532 = 0.126 (SC3)
67/375 = 0.179 (LC1)
67/376 = 0.179 (LC2)

Table II-13 Autotrophic Index values and chlorophyll a/ pheophytin a ratios for periphyton algae collected from backwater areas of Stanley and Lake Creeks on October 20, 1977

	AUTROPHIC INDEX		
STATION	MEASURED	ADJUSTED*	CHLOROPHYLL/PHEOPHYTIN RATIO
SC3	665	532	1.35
LC1	469	375	1.43
LC2	470	376	1.58

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*Calculated by adding 25 percent to the measured chlorophyll a values to compensate for a possible underestimation of absorbance by using a spectrophotometer with a band width of eight nm (APHA 1975).

Thus, roughly 13 percent or 15 mg m^{-2} day^{-1} of the total organic accrual in Stanley Creek was due to the autotrophic (algal) portion alone. About 18 percent of 18 mg m^{-2} day^{-1} was contributed by the autotrophs in Lake Creek. The remainder, or 100 mg m^{-2} day^{-1} in Stanley Creek and 84 mg m^{-2} day^{-1} in Lake Creek can be attributed to the heterotrophic fraction. Because the visible macroinvertebrates were removed from the slides before the gravimetric and pigment analyses, the heterotrophic portion of the periphyton can be assumed to consist mainly of protozoa, fungi, bacteria and sedimented organic matter.

Chlorophyll/pheophytin ratios in Table II-13 are somewhat higher than those measured for periphyton colonizing the glass slides. The average value for both streams was 1.45, which is about two-thirds the distance from 1.00 (poor condition) to 1.70 (excellent condition). Thus, the physiological condition of the periphyton algae on natural substrates in October might be rated "good".

(4) Periphyton

> *The planktonic communities of the lake and creeks are dominated by diatoms. Plankton are important trophic levels of lakes, but Aufwuchs are more important in streams since they are attached permanent residents. Future studies should include the Aufwuchs communities.*
>
> Stearns-Roger, Inc. (1975)
> Environmental Baseline Report (p. 5-52)

The Aufwuchs or periphyton is the slippery film of living and non-living organic matter coating the upper surfaces of rocks and other substrates on the stream bed. The living fraction of the periphyton normally consists of an association of microscopic plants (algae, bacteria and fungi) and animals (protozoa, nematodes, rotifers, first instar insects and other primitive organisms). In streams the size of Lake Creek and Stanley Creek, it is the principal site of photosynthesis and primary production. Together with vegetable matter contributed by streamside terrestrial communities, the periphyton produces the fuel that drives the aquatic community. In this role, it shares the critical first rung on the food ladder leading to fish and fish-eating animals.

Plankton and macrophytes are relatively unimportant constituents of the floras of Lake Creek and Stanley Creek. These plant types generally do not fare well because of steep gradients, high current velocities and turbulence. However, bryophytes (mosses) are relatively common in both streams, and submerged macrophytes occasionally gain a foothold in quiet, silt-bottomed backwaters. Except immediately below the outlet of Bull Lake, the plankton of these streams consists primarily of periphyton organisms that occasionally become detached from their moorings.

Plankton data gathered by Stearns-Roger, Inc. are presented in Appendix J. Some observations should be recorded here regarding the plant (algal) fraction of the plankton communities surveyed by this firm. Of the 32 genera of algae reported from the "plankton" of Lake Creek, Stanley Creek and Ross Creek, only seven are known to include species that are truly planktonic; the remaining genera include taxa that are normally either attached to or resting upon a substrate, i.e., they are either periphytic or tychoplanktonic. It is evident from these data that these streams do not support a viable plankton community. The occurrence of true plankton algae in Lake Creek can be accounted for by overflow from Bull Lake but the origin of the plankton algae found in Stanley Creek and Ross Creek is unclear. Particularly perplexing are the relatively high concentrations of *Microcystis* found in these streams. *Microcystis* is a colonial blue-green alga typically found in the summer plankton of eutrophic, hardwater lakes.

In response to the Stearns-Roger recommendation, the Water Quality Bureau has focused its attention on the periphyton (*Aufwuchs*) rather than on the plankton communities of the Lake Creek system with respect to the aquatic flora. Particular emphasis was placed on the diatoms, which were noted by Stearns-Roger to dominate the phytoplankton communities. Because, as explained above, the "plankton" of the small streams derives largely from the periphyton, it was suspected that diatoms also dominated the periphyton, which in fact they do. In addition to their intrinsic trophic significance, diatoms are also valuable indicators of water quality.

Periphyton material was scraped from natural substrates, particularly rocks, with a small pocket knife that was carefully rinsed after each collection. Rocks were chosen from both pool and riffle locations and the entire surface area of each was scraped clean. Pieces of wood and the mud of calm backwaters were also sampled in proportion to their total contribution as substrates at a given station. In addition, the stream bottom in the vicinity of each station was scanned for about 15 minutes and any conspicuous filamentous or colonial algae were sampled in proportion to their relative abundance. Such a procedure provided a composite collection from each station (Bahls, 1971). The samples were then preserved with several drops of Lugol's (IKI) solution and transferred in small wide-mouth jars to the laboratory for algal enumeration.

In the laboratory, the sample was thoroughly agitated and a subsample pipetted onto a microscope slide having a small round depression. Pieces of macroscopic colonies and filaments large enough to enable identification were also placed on this slide approximately in proportion to their abundance in the sample. A coverslip was then placed over the depression and this wet mount was scanned under 100X and 400X. All nondiatom taxa were identified to genus and their abundance was estimated, relative both to one another and to the diatoms as a group. Keys used in nondiatom algae identification were Smith (1950) and Prescott (1962 and 1964).

To make a detailed evaluation of the diatom populations, the diatoms were first "cleaned" using concentrated sulfuric acid and potassium dichromate. This method enhances the mixing and randomization of frustules for quantitative counting and removes the protoplastic cellular contents that obscure the surface ornamentation, which must be visible for accurate identification. The cleaned material was then mounted in "Carmount-165 Medium" (manufactured by Cargille Laboratories, Inc.) according to the method of the Federal Water Pollution Control Administration (now EPA) (1966). A total of 22 slides was prepared in this manner.

A diatom proportional count was then performed on each slide according to the method outlined by the Environmental Protection Agency (1973). The only significant exception to this method was then in excess of 500 cells, rather than the recommended 250 cells, were identified and enumerated. McIntire and Overton (1971) found that commonly used diversity indexes changed relatively little beyond sample sizes of 300 and subsequently recommended 500 as a suitable sample size for estimates of diatom diversity. Keys used for diatom algae identification were Hustedt (1930a, 1930b, 1959 and 1966), Patrick and Reimer (1966 and 1975) and Cleve-Euler (1951).

From these counts, the following indexes were calculated:

Diversity (EPA, 1973) $- = \underline{C} \quad (N \log_{10}N - \quad n_i \log_{10}n_i)$

Equitability (EPA, 1973) $e = s'$

Percent Community Similarity (Whittaker and Fairbanks, 1958)
$PCS = 100 - 0.5 \quad a - b$

Proportional count results were also used to determine the relative contribution to the diatom flora of attached, tychoplanktonic and planktonic taxa as well as the indicator genera Achnanthes and Nitzschia. Species of the genus Achnanthes generally indicate an aquatic environment that is rich in dissolved oxygen and low in organic pollution; the total relative abundance of taxa in the genus Nitzschia is generally proportional to the amount of nitrogenous enrichment that a stream receives (Chlonoky, 1968).

A summary of periphyton data for streams of the Lake Creek drainage is included in Table II-14.

Table II-14 Summary of periphyton data for streams of the Lake Creek drainage

Stream	No. Non-Diatom Genera	No. Diatom Genera	No. Diatom Taxa	Diatom Frustules Counted
North Adit Discharge	4	5	6	1056
Stanley Creek	15	25	127	3734
Lake Creek	23	35	278	5516
Keeler Creek	1	10	14	521
Kootenai River	4	19	45	542
Ross Creek	5	18	51	535
All Streams	32	37	330	11904

A total of 32 genera of nondiatom algae was identified from the periphyton communities of the Lake Creek drainage. The estimated abundances of these genera, relative to diatoms and to one another, are listed in Appendix K. From these data, it is evident that the periphyton of the drainage was dominated by the algal division Chrysophyta, particularly the diatoms. Other algal divisions in decreasing order of importance were the Chlorophyta (green algae), the Cyanophyta (blue-green algae) and the Rhodophyta (red algae). Together with the taxa identified by Stearns-Roger, Inc. (1975) (Appendix J), the nondiatom flora of the Lake Creek drainage, including Bull Lake, consists of at least five divisions and 38 genera. In this study, the largest number of nondiatom genera (23) was found in Lake Creek and the second highest number (15) was found in Stanley Creek (Table II-14).

Totals of 37 genera and 330 distinct diatom taxa were identified from the periphyton communities of the Lake Creek drainage (Table II-14). These taxa, along with their percent relative abundances (PRA) on each of the dates and each of the six streams sampled, are given in Appendix L. Almost 12,000 cells were enumerated altogether. By far the greatest number of diatom taxa was found in Lake Creek (278) and the fewest in the North Adit discharge (6). Of the 330 diatom taxa recorded for the drainage, 19 species, 10 varieties and two forms are new to Montana. These taxa are listed in Table II-15. In addition, 37 taxa could not be located in available keys; it is likely that at least some of these are either new to Montana or new to science.

Table II-15 Diatom taxa from the Lake Creek drainage that are new to Montana

	Lake Creek	Stanley Creek
Achnanthes linearis var. pusilla Grun.	X	
Achnanthes maxima A. Cl.	X	
Achnanthes maxima var. lanceolata str.	X	
Achnanthes peragalli var. fossilis Temp. and Perag.	X	
Achnanthes peragalli var. parvula (Patr.) Reim.	X	X
Achnanthes rupestris Krasske	X	X
Achnanthes subrostrata Hust.		X
Caloneis limosa (Kutz.) Patr.	X	
Cocconeis klamathensis Sov.	X	
Eunotia praerupta var. bidens (Ehr.) Grun.	X	
Fragilaria virescens var. mesolepta Rabh.	X	
Gomphonema angustatum var. citera (Hohn and Hellerm.) Patr.		X
Gomphonema manubrium Fricke	X	
Gomphonema simus Hohn and Hellerm.		X
Melosira ambigua (Grun.) O. Mull.	X	
Navicula acceptata Hust.	X	
Navicula aerophila Krasske	X	
Navicula bicephala Hust.	X	
Navicula contenta Grun.	X	
Navicula contenta f. biceps (Arnott) Grun.		X
Navicula menisculus Schum.	X	
Navicula mournei Patr.	X	
Navicula paucivisitata Patr.		X
Navicula pseudosilicula f. olympica Sov.	X	
Navicula pupula var. mutata (Krasske) Hust.	X	X
Navicula schmassmanii Hust.	X	
Navicula semen Ehr. emend Donk.	X	
Navicula semenoides Hust.	X	
Navicula seminulum var. radiosa Hust.	X	
Pinnularia borealis var. brevicostata Hust.		X
Stauroneis fluminea Patr. and Freese	X	

Table II-16 lists values for selected diatom community parameters from streams of the Lake Creek drainage. All of the "major taxa" listed in this table, i.e., taxa that contributed 10 PRA or more in one or more samples, with the possible exception of Diatoma vulgare and Stephanodiscus minutus, are indicators of clean, cold water with low dissolved solids and high dissolved oxygen. The two exceptions were abundant only in the Kootenai River, which had a diatom flora quite dissimilar from those of the other streams. The simplest, most depauperate diatom flora was found in the North Adit discharge; judging by the kinds of diatoms dominating the flora here, the extremely low diversity of the NAD sample was probably due to cold, stenothermal water conditions. The richest flora with the highest diversities was found in Lake Creek. The variety of sources of Lake Creek, including Bull Lake and Stanley Creek, probably accounted for some of this higher than average diversity; however, at least 22 of the taxa of Lake Creek are apparently found nowhere else in the drainage.

Values for the diversity index - generally fall between three and four in unpolluted waters and less than one in polluted waters. Equitability, which is thought to be even more sensitive to changes in water quality, ranges in excess of 0.5 in clean water to less than 0.3 in water polluted with oxygen-demanding wastes (EPA, 1973). Diversity and equitability values were mostly satisfactory for all streams except the North Adit discharge and Keeler Creek (Table II-16). Caution must be exercised in interpreting these data for two reasons: 1) seasonal fluctuation in diatom diversity is a natural phenomenon, with the peak in diversity usually occurring in July or August; and 2) a chemically and/or physically austere environment (e.g., a cold water stream draining igneous rock at a high altitude) can result in a depauperate flora, giving a false impression of pollution.

The consistently high PRA Achnanthes spp. and low PRA Nitzschia spp. (Table II-16) indicate that none of the water samples suffer for oxygen-demanding wastes, dissolved oxygen sags, or excess nitrogen enrichment. Even the North Adit discharge, which had the highest TSIN value, had no Nitzschia spp., again suggesting that low temperature was probably the controlling parameter here.

Near the bottom of Table II-16 are figures indicating the PRA of diatoms comprising the three basic growth habits: attached, tychoplanktonic and planktonic. Attached diatoms are connected to the substrate by a stalk or tube; they are sedentary, require a firm substrate and are not capable of changing their position. Tychoplanktonic diatoms either move over or rest upon the bottom; they frequently become part of the plankton as a result of turbulence or scouring. Planktonic diatoms spend most of their life cycles drifting passively in the open water; they are commonly restricted to lakes, reservoirs and large rivers. The data in Table II-16 indicate that for most waters in the drainage the attached growth habit is more important than the tychoplanktonic growth habit, which in turn is much more important than the planktonic habit. Planktonic diatoms

TABLE II-16 Values for selected diatom community parameters from streams of the Lake Creek Drainage (1977-1978). PRA = Percent Relative Abundance; "MAJOR TAXA" are those that contribute 10 PRA or more in one or more samples.

STATION

	NAD		SC1		SC2	SC3			SC4	LC1	
PARAMETER	7/19/77	10/20/77	7/19/77	2/9/78	7/19/77	3/21/77	7/20/77	10/20/77	4/20/77	4/20/77	7/20/77
PRA MAJOR TAXA											
Achnanthes deflexa						6.8	37.3	23.8	11.4	61.0	3.1
A. lanceolata			16.1	0.4	45.9	0.8	1.1	0.6	0.2	t	0.4
A. microcephala				t		4.3	0.4	5.7	1.0	19.7	1.6
A. minutissima	14.8	60.2	28.0	56.8	16.8	39.3	28.4	22.4	60.4	0.2	19.4
Asterionella formosa											
Cymbella minuta	3.6	4.2	1.7	1.1	0.6	8.2	3.6	1.6	1.2	0.2	1.6
Diatoma hiemale var. *mesodon*	81.6	35.6	9.5	4.3	5.5	6.8	6.6	16.0	2.9	t	0.4
D. vulgare											
Gomphonema olivaceoides			0.2			0.8	1.4		0.2	5.0	t
G. quadripunctatum			11.2	2.6	1.1		t	t			
Stephanodiscus minutus											
TOTAL TAXA	4	5	34	36	37	63	45	43	56	54	133
TAXA COUNTED	3	3	29	29	28	36	36	30	37	28	80
FRUSTULES COUNTED	528	528	535	540	525	512	557	545	520	554	515
DIVERSITY ($\bar{d}$)	0.82	1.16	3.35	2.85	2.88	3.40	2.98	3.46	2.59	2.01	4.94
EQUITABILITY (e)	0.67	1.00	0.52	0.34	0.36	0.42	0.31	0.53	0.22	0.18	0.58
PRA *Achnanthes* spp.	14.8	60.2	47.4	68.3	64.8	55.9	69.0	53.8	77.1	81.1	28.7
PRA *Nitzschia* spp.	0	0	9.8	7.0	2.7	8.2	1.2	1.3	2.7	0	3.5
PRA Attached spp.	14.8	64.4	63.9	73.8	73.2	57.9	75.6	61.7	79.2	86.7	31.3
PRA Tychoplanktonic spp.	85.2	35.6	36.1	26.3	26.8	42.1	23.0	37.9	20.8	12.0	54.7
PRA Planktonic spp.	0	0	0	t	0	0	1.4	t	0	1.3	14.0
No. Planktonic Taxa	0	0	0	1	0	0	1	1	0	8	10

TABLE II-16 Continued

	STATION										
	LC1		LC2				KC1	LC3	LC4	KR1	RC1
PARAMETER	10/20/77	2/10/78	4/19/77	7/20/77	10/20/77	2/10/78	4/20/77	3/21/77	4/21/77	4/21/77	7/21/77
PRA MAJOR TAXA											
Achnanthes deflexa	4.7	5.8	6.0	6.0	6.5	3.1		1.0	2.9	t	8.8
A. lanceolata	0.2	0.4	0.4	0.2	0.2	0.2	0.2		0.4	t	0.9
A. microcephala	2.4	2.3	36.0	2.2	2.2	t	80.2	2.4			46.0
A. minutissima	21.1	16.0	3.2	41.1	29.7	23.0		46.9	40.6	20.8	
Asterionella formosa	0.2	22.8		0.2	17.4						
Cymbella minuta	2.4	1.4	5.2	3.4	1.4	4.1	1.5	13.6	12.0	6.8	3.6
Diatoma hiemale var. *mesodon*			0.2		0.2	t	t	2.2	1.0	0.2	2.4
D. vulgare										22.3	
Gomphonema olivaceoides		1.9	2.2	0.2	t	0.2	10.2	0.2		t	5.4
G. quadripunctatum		0.5		0.4	0.4		2.9				
Stephanodiscus minutus									0.4	26.6	0.8
TOTAL TAXA	88	101	100	105	108	77	14	48	65	45	50
TAXA COUNTED	64	60	52	66	64	48	9	38	57	29	38
FRUSTULES COUNTED	531	574	533	579	552	556	521	597	525	542	535
DIVERSITY ($\bar{d}$)	4.70	4.23	3.89	3.91	4.33	4.19	1.10	3.12	3.81	3.13	3.22
EQUITABILITY (e)	0.60	0.47	0.42	0.33	0.47	0.55	0.33	0.32	0.35	0.41	0.34
PRA *Achnanthes* spp.	32.3	28.0	47.9	52.3	43.4	29.5	80.4	58.9	46.4	20.8	57.1
PRA *Nitzschia* spp.	1.3	1.0	2.8	2.6	4.7	2.9	0.2	4.1	7.8	2.2	1.0
PRA Attached spp.	46.8	34.2	52.6	56.8	57.0	38.2	98.1	63.9	49.5	24.8	80.3
PRA Tychoplanktonic spp.	41.7	31.5	38.7	36.9	36.9	31.4	1.9	35.1	46.6	47.1	19.7
PRA Planktonic spp.	11.8	35.6	8.7	6.3	8.7	30.8	0	1.0	3.9	28.1	0
No. Planktonic Taxa	10	8	7	8	9	9	0	4	8	6	0

were significant only in Lake Creek (below Bull Lake) and in the Kootenai River (below Lake Koocanusa). The predominance of attached diatoms is significant from the standpoint of impact evaluation; these diatoms would suffer most in the event of accelerated siltation because they need a firm substrate to survive. Tychoplankters, on the other hand, would be much more capable of maintaining themselves over a shifting, unstable substrate.

The similarity between "baseline" diatom floras at stations LC1 and LC2 (above and below the site of the proposed tailings pond) might be of interest for comparison with floras that may colonize these sites following development. Thus, the percentage community similarity (PCS) index was computed for these two stations on each of the four dates they were sampled. The PCS index for diatoms was 33.7 in April, 62.0 in July, 56.8 in October and 66.6 in February; in other words, the two floras were fairly dissimilar in April and fairly similar in July, October and February, but not as similar as one might expect on any date. (As will be seen in the next section, much the same trend holds for the benthic macroinvertebrates except that the faunas are more similar on most dates.)

2. Aquatic Fauna

a. Macroinvertebrates

Macroinvertebrates are animals without backbones that are large enough to be seen with the unaided eye. They live upon or burrow into the bottom of a stream. Most macroinvertebrates are immature insects, but the group also includes sponges, crustaceans, flatworms, roundworms, earth worms, mites, snails, clams and adult insects. This loosely organized group of small aquatic animals provides the critical transition between a stream's primary production and its eventual output of fish flesh. Generally, macroinvertebrates eat plant material and fish eat macroinvertebrates; without macroinvertebrates there would be no fish. Like diatoms, these animals are also excellent indicators of water quality, individually and collectively as expressed in indexes of community structure.

Prior to 1977, macroinvertebrate data were collected from the Lake Creek drainage by the Montana Department of Health (1968), the Montana Department of Fish and Game (1972 and 1973) and Stearns-Roger, Inc. (1974). The results of these studies, although quite variable in the detail of taxonomic identification, generally indicate that streams in the drainage possess a diverse benthic fauna composed primarily of pollution sensitive taxa. (The terms "pollution sensitive" or "pollution intolerant" are ordinarily used in the context of sensitivity to oxygen-demanding organic waste, but they may also be used in the sense of siltation and susceptibility to suffocation by excessive inorganic sediment.)

The 1977-1978 State of Montana Water Quality Bureau baseline macroinvertebrate sampling program consisted of five replicate Surber square-foot collections at each station and on each date sampled (Table II-11). Conditions at LC2 are not amenable to Surber sampling because of the large rocks at this station; however, suitable locations were found after considerable searching. Bottom conditions at the other stations were nearly ideal: shallow riffles with medium-sized bottom materials. At all stations, an attempt was made to sample comparable riffle areas. It is suspected that the rather large mesh net used on the Surber frame (ca. 20 meshes per inch) allowed some of the smaller instars, particularly of the Diptera, to pass through.

Each Surber sample was bottled separately and preserved with formaldehyde. All taxa were identified to genus except those in the dipteran family Empididae, the Turbellaria (flatworms), the Corixidae (water boatmen), the Pelecypoda (clams), the Gastropoda (snails), the Porifera (sponges), Hydracarina (mites) and the Oligochaeta (earth worms). Keys used in macroinvertebrate identification were Usinger (1968), Pennak (1953), Ross (1944), Edmondson (1959) and Mason (1973). Animals in each square-foot sample were sorted by taxa and counted.

As with the diatoms, macroinvertebrate counts were used to compute diversity (-), equitability (e) and percent community similarity (PCS); diversity and equitability were computed for the five Surber collections pooled for each station on a given date. The percentages of pollution tolerant, facultative and pollution intolerant organisms were also determined for each station/date according to an EPA (1973) rating table. (If a genus was not listed in the table, it was assumed to have a tolerance equal to that of the next higher taxonomic category listed.)

A list of organisms and numbers of taxa and organisms found in individual Surber samples may be found in Appendix M. Sixty-one taxa were identified in the Surber samples; all were insects except for flatworms, clams, snails, mites and earth worms. "Qualitative" collections were also made from various habitats at each station on each sampling date; only an adult beetle of the family Dytiscidae (LC2/4-19-77), a freshwater sponge and a water boatman (bug) (LC1/4-20-77) were found in the qualitative samples and not in the quantitative (Surber) samples. Stearns-Roger, Inc. (1975) reported an additional 18 taxa for the Lake Creek drainage (including Ross Creek and Bull Lake), bringing the recorded number of macroinvertebrate taxa to 82. Total numbers of organisms per unit bottom area were generally higher in fall and winter and lower in spring and summer.

Pooling the data for all five Surber samples on a given date provides an accurate and reliable picture of macroinvertebrate abundance, diversity and tolerance; pooled data are presented in Table II-17. Diversity and equitability values reflected unpolluted waters; adequate sample size precludes any doubt as to the reliability of these parameters. It is also evident that most of the animals living in Lake and Stanley Creeks are pollution sensitive or pollution intolerant. Very similar percentages of pollution intolerant organisms were reported by the Montana Department of Fish and Game (Stearns-Rogers, 1975). It should be noted that many of

Table II-17 Values for selected benthic macroinvertebrate parameters from Lake Creek and Stanley Creek (1977-1978). Figures are for 5 pooled square foot Surber samples at each station.

	SC3				SC4	LC1			
PARAMETER*	3-21-77	7-20-77	10-20-77	2-9-78	4-20-77	4-20-77	7-20-77	10-20-77	2-8-78
No. Animals	205	388	1082	1051	481	584	282	743	1578
No. Taxa	14	25	30	37	34	28	26	35	39
Diversity ($\bar{d}$)	3.70	2.80	3.63	3.75	3.57	3.74	3.56	3.45	3.70
Equitability (e)	0.61	0.71	.60	.51	0.61	0.73	0.68	.46	.49
Tolerant Animals (%)	0.6	0	0	0	0.3	0	0	0	0
Facultative Animals (%)	12.2	5.4	7.0	5.5	11.8	21.3	16.2	9.7	14.8
Intolerant Animals (%)	87.2	94.6	93.0	94.5	87.9	78.7	83.8	90.3	85.2

*Diversity, equitability, and tolerance values were calculated following procedures outlined by the U.S. Environmental Protection Agency (1973).

(Continued)

Table II-17 (Continued)

	LC2				LC3
PARAMETER*	4-19-77	7-20-77	10-20-77	2-10-78	3-21-77
No. Animals	683	311	1195	1248	172
No. Taxa	36	31	37	38	13
Diversity ($\overline{d}$)	3.31	3.87	3.46	3.81	2.57
Equitability (e)	0.39	0.62	.43	.53	0.62
Tolerant Animals (%)	0	0.4	0	.2	0
Facultative Animals (%)	6.4	37.2	9.2	5.6	0.6
Intolerant Animals (%)	93.6	62.4	90.8	94.2	99.4

*Diversity, equitability, and tolerance values were calculated following procedures outlined by the U.S. Environmental Protection Agency (1973).

the dipteran genera from the Lake Creek drainage are pollution sensitive, although the order Diptera is generally considered to be composed mostly of tolerant or insensitive taxa. "Sensitive" and "intolerant" are used here in the context of the amount or availability of dissolved oxygen in the water. Sensitive animals are normally those that breathe by means of gills and lack special adaptions for adjusting to extremely low levels of dissolved oxygen or for entrapping atmospheric oxygen at the water's surface. As stated before, these animals are susceptible to both oxygen-demanding organic wastes and to excessive sediment on the stream bottom.

The percentage community similarity (PCS) index for macroinvertebrates at stations LC1 and LC2 was 65.2 in April, 73.8 in July, 69.1 in October and 61.8 in February. In other words, the faunas at the two stations were fairly similar in winter and spring, and even more similar in summer and fall. PCS index values for these stations can be compared before, during and after mining as a monitor of the effects of tailings pond construction, operation and reclamation on the biota of Lake Creek.

b. Fish

(1) Methodology

(a) Electrofishing Techniques and Population Estimates

Fish were collected from Lake Creek and Stanley Creek using standard electrofishing gear. Captured fish were anesthetized, measured, weighed, marked or tagged and released. Scales were taken from approximately 20 fish per inch group. Standard fishery methods were used in making plastic impressions of the scales and in age determinations. Methods described by Vincent (1971) were followed during electrofishing operations and in analyzing mark-recapture data. A computer program developed by the Montana Department of Fish and Game was used to do the actual computations. Sufficient fish were marked to obtain population estimates for the upper bridge section in Stanley Creek in 1977 and the Camp Creek section in 1974 but insufficient fish were collected in 1977 to make valid population estimates for the Little Joe and Camp Creek sections of Lake Creek. The upper bridge section was 1,000 feet in length, the Little Joe section was 8,000 feet in length and the Camp Creek section was 5,000 feet in length (Figure II-4).

Sculpin estimates were obtained from two riffles each in the Little Joe and Camp Creek sections using the Leslie Depletion Method described by Richer 1958). A block net was installed below each riffle and sculpin were collected using a coffelt backpack shocker. Each riffle was electrofished thoroughly four times. Each riffle was mapped using a transit,

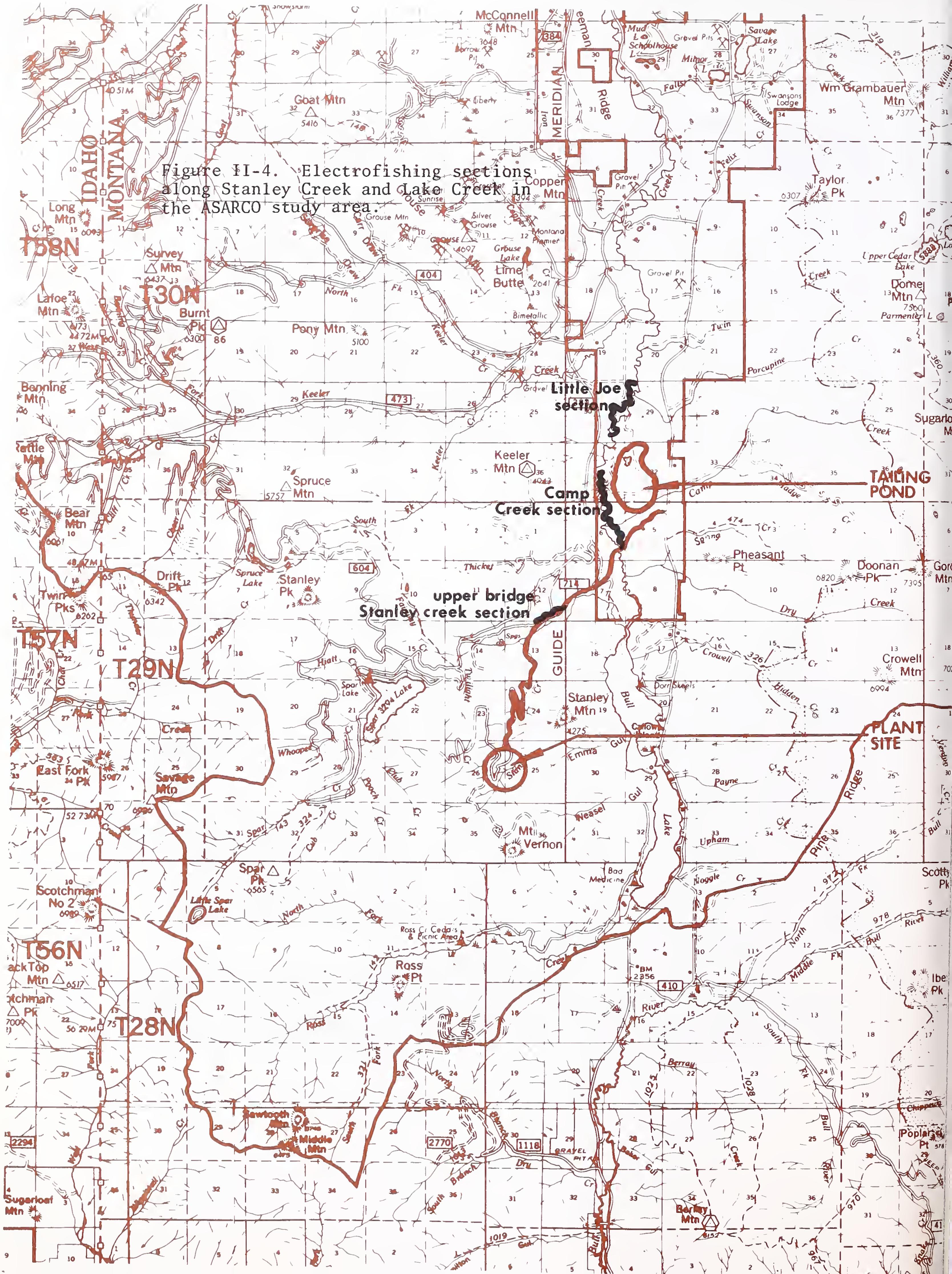

Figure II-4. Electrofishing sections along Stanley Creek and Lake Creek in the ASARCO study area.

stadia rod and tape, and the area determined with the aid of an area digitizer. Two flow readings were taken at each riffle following standard methods recommended by the U. S. Geological Survey, (Shields, 1969).

(b) Underwater Fish Census Techniques

Trout inhabiting the pools in the Little Joe and Camp Creek sections were censused using the snorkeling techniques described by Pollard and Bjourn (1973).

(c) Spawning Run Surveys

A standard box trap with poultry netting leads was installed in Keeler Creek approximately one-half mile from the mouth to monitor the Dolly Varden from Bull Lake which enter Keeler Creek to spawn. Dolly Varden captured in the trap were anesthetized, measured, weighed, tagged and scale sampled, before being released upstream.

(d) Fishing Pressure Estimates and Angler Catch Rates

Fishing pressure estimates were taken from state wide fishing pressure surveys conducted in the 1968-1969 and the 1975-1976 fishing seasons. The methodology for the surveys was developed by the Montana Department of Fish and Game.(Bureau of Outdoor Recreation Project No. 30-00274).

Angler success and catch rate data for Lake Creek was taken from the Fisherman Log Program (Holton, 1977).

(e) Heavy Metals Concentrations in Fish Tissue

Fish were collected from Lake Creek and Stanley Creek using electrofishing gear. Captured fish were placed in ice for several hours until transport to Libby. After transport the entrails were removed (except for sculpins) and the fish placed in plastic bags and frozen in preparation for being sent to the Department of Health and Environmental sciences Laboratory in Helena for analysis.

A sample of fish muscle tissue was used from trout for the analyses whereas the whole fish was utilized for the sculpin analyses. The fish tissue was prepared using standard methods for oxidizing flesh for heavy metals analysis.(Dolezol, et. al., 1969), (Holack, et. al., 1972), (Sunderman, et. al., 1974).

The analyses were carried out by the Atomic Absorption spectrometry following methods outlined in "The Manual of Chemical Analyses of Water and Waste Water, EPA 1974". The results were expressed as U/gm dry weight.

(2) Population Studies

The following fish species were collected during electrofishing surveys in Lake Creek; rainbow trout (*Salmo gairdneri*), cutthroat trout (*Salmo Clarki*), brook trout (*Salvelinus fontinalis*), Dolly Varden (*Salvelinus malma*), Mountain Whitefish (*Prosopium williamsoni*), large-scale suckers (*Catostomus macrocheilus*), slimy sculpin (*Cotlus cognatus*), northern squawfish (*Ptychocheilus oregonensis*), longnose dace (*Rhinichthys cataractae*) and rainbow X cutthroat trout hybrids, Brook trout, cutthroat trout, slimy sculpins and cutthroat X rainbow hybrids were collected from Stanley Creek.

Fish popultion data collected from the two study sections in Lake Creek are summarized in Tables II-18, II-19 and II-20. Population estimates were obtained in 1974 for yearling and older rainbow (341) and Brook trout (226) from the Camp Creek Section. The total estimate of 567 yearling and older trout weighing 128 pounds in the 5,000 foot section is indicative of a good trout population for this size stream. The estimate is probably less than the actual population because fish could not be sampled efficiently in the deep pools common in Lake Creek. Most fish were collected from under cut banks with overhanging brush and from under log jams in the shallower reaches of the stream less than three feet deep.

Table II-18 Population estimates and condition factors for yearling and older rainbow trout and brook trout from Camp Creek section of Lake Creek, September 1974. Eighty percent confidence limits are given in parenthesis

Species	Size Range in Inches	Avg. Length in Inches	Avg. Weight in Pounds	Number Estimate	Weight Estimate	Condition Factor
Rainbow Trout	4.7-18.0	9.0	.26	341 (±37%)	87	36.26
Brook Trout	5.0-13.3	8.0	.18	226 (±19%)	41	37.83

Table II-19 Age composition, growth and condition factors for yearling and older rainbow trout and brook trout electrofishing catches from Camp Creek section of Lake Creek, August 1977

Year Class	Age Class	Number of Fish in each Age Class	Average Length Inches at Capture	Average Weight in Pounds at Capture	Average Condition Factor
			RAINBOW TROUT		
1976	1+	47	5.3	.06	
1975	2+	12	9.4	.39	
1974	3 and older	5	14.8	1.22	
		64	6.8	.21	36.99
			BROOK TROUT		
1976	1+	55	6.3	.11	
1975	2+ and older	6	9.8	.39	
	Totals	61	6.7	.13	39.24

A population estimate was not obtained in 1977 because sufficient trout were not marked due to an apparent decrease in the population from 1974. The exact reason for the population decline is not known, but it is probably a result of major floods in the drainage in January 1974 and December 1975 adversely affecting juvenile trout survival. The age composition of brook trout population in 1977 indicated that the 1974 and 1975 year classes were very weak. Only 9.8 percent and 4.3 percent of the brook trout from the Camp Creek and Little Joe section, respectively, were age two and older. The eggs of the brook trout would have been inculating in the gravels during the 1974 and 1975 floods and thus, quite susceptible to high mortalities from bedload movement during the floods. Hoopes (1975) documented that floods had a disasterous impact on young-of the-year brook trout populations. The age structure of the rainbow trout populations appeared more typical in both sections, but the population on the Camp Creek section was noticeably less in 1977 than in 1974. The record low flows in 1977 undoubtly affected fish distribution and abundance in Lake Creek through reduced quality and quantity of fish habitat. The variation in year class strengths and fish distribution and abundance from year to year demonstrate the necessity of collecting several years of baseline data to define the natural occurring population fluctuations.

Table II-20 Age composition, growth and condition factors for yearling and older rainbow trout and brook trout electrofishing catches from Little Joe section of Lake Creek, August 1977

Year Class	Age Class	Number of Fish in each Age Class	Average Length in Inches at Capture	Average Weight in Pounds at Capture	Average Condition Factor
			RAINBOW TROUT		
1976	1+	34	5.3	.06	
1975	2+	10	8.8	.26	
1974	3+	5	11.2	.55	
1973	4 and older	11	15.6	1.39	
Totals		60	8.2	.38	38.34
			BROOK TROUT		
1976	1+	44	5.8	.08	
1975	2+ and older	2	9.2	.34	
Totals		46	6.0	.10	40.83

The growth of rainbow and brook trout is above average for other streams in the area (May, 1972). Age 2+ rainbow trout from the Fisher River average 6.9 inches in total length as compared to 9.4 inches for age 2+ rainbow from the Camp Creek section.

A change in the species composition of the trout population appears to have occurred since 1959. Hanzel (1954) noted cutthroat trout were the most abundant game fish taken by anglers from Lake Creek. The electrofishing data collected in 1974 and 1977 indicated that the trout population consisted primarily of rainbow and brook trout, with cutthroat trout being comparatively rare. A similar pattern of species composition change was indicated by the creel data.

A population estimate of 281 brook trout weighing 8.9 pounds was obtained for a 1,000 foot section in Stanley Creek (Table II-21). The growth of these fish is noticeable less than that recorded for brook trout from Lake Creek. Growth of Trout in small cold head water streams is usually less than warmer more fertile valley streams. The age structure of the brook trout population appears normal with 66 percent being age 1+ and 34 percent age 2+ and older. Stanley Creek receives most of its flow from springs and was affected comparatively little by the 1974 and 1975 floods.

Table II-21 Population estimates, age composition, growth and condition factors for brook trout from the upper bridge section of Stanley Creek, August 1977. Eighty percent confidence limits are given in parenthesis

Year	Age	Number of Fish in each Age Class	Weight in Pounds of Number Estimate	Avg. Length in Inches at Capture	Average Weight in Pounds	Avg. Condition Factor at Capture
1976	1	184	7.0	4.4	.04	
1975	2+ and older	97	8.9	6.0	.09	
		281(±16.8%)	15.9			41.70

Freshwater sculpins often constitute an important component of the fish biomass in streams ecologically suited to salmonoids. Sculpins like trout are best adopted to streams with excellent water quality and are quite sensitive to pollutants. Sculpins are generally stationary benthic fish which inhabit riffle areas, feed almost exclusively on aquatic insect larvae and complete their life cycle within a limited stream section. These characteristics make them ideal "indicater organisms" because sculpin populations are easily monitored and respond rapidly to changes in the stream environment.

Habitat and population data for slimy sculpins inhabiting four riffles in Lake Creek are given in Table II-22. Sculpins were most abundant in the Riffle 2 of the Camp Creek section and Riffle 2 of the Little Joe section where the average water velocity approached one foot per second, the average depth was close to two feet and the substrata was composed of 85-90 percent cobble. Sculpins were least abundant in the Riffle 1 of the Camp Creek section where 95 percent of substrata was gravel with the remainder consisting of sand. Young of the year fish were separated from yearling and older fish using length frequency

Table II-22 Habitat parameters and population estimates for slimy sculpins from riffles in Camp Creek and Little Joe sections of Lake Creek. Ninety-five percent confidence limits for estimates given in parenthesis. Velocity is given in feet per second, depth is in feet and area is square feet

Avg. Lengths in Inches	Range in Length in Inches	Population Estimates	Number Per 1000 sq' Riffle	Riffle Area	Average Depth	Average Velocity	Gradient (% slope)	Substrata
			Riffle 1 - Camp Creek section					
1.9	1.3 - 3.2	39 (28-81)	26.3	1482	1.04	1.7	0.90%	95% gravel 5% sand
			Riffle 2 - Camp Creek section					
2.1	1.2 - 3.3	373 (288-670)	125	2990	0.98	2.1	0.87%	85% cobble 10% gravel 5% sand
			Riffle 1 - Little Joe section					
2.0	1.3 - 3.6	209 (1/)	78	2683	0.79	2.5		80% cobble 20% gravel
			Riffle 2 - Little Joe section					
2.2	1.2 - 3.3	379 (364-396)	132	2881	0.92	1.8	0.62%	90% cobble 5% gravel 5% sand

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1/Confidence limit not calculated because only three removal runs were made.

tables and estimates include the yearling and older members of the population. The population densities in Riffle 2 in the Little Joe (132/1000 square feet) and Camp Creek (125/1000 square feet) sections were higher than recorded (105/1000 square feet) by Petrosky and Waters (1975) in a small fertile Minnesota trout stream. Few of the slimy sculpins in their study lived longer than three years and most of the production was accounted for by age groups zero and one. The comparatively dense slimy sculpin populations in Lake Creek is an indication of excellent water quality and good aquatic insect production.

Results from the underwater fish census are summarized in Table II-23. The efficiency of the survey varied from pool to pool depending on the amount of sunken debris and logs. The overall efficiency of observation was estimated to be around 70 percent. Only 19 rainbow trout were observed in the Camp Creek section and 36 from the Little Joe section. Brook trout were not observed in pool areas in the Camp Creek section and only three were seen in the Little Joe section. Electrofishing data indicated that brook trout were almost as abundant as rainbow trout in both sections. The difference in the species composition of the two surveys can be accounted for by habitat preferences of the two species and the selectivity of the electrofishing gear as noted earlier. The data generated by an underwater fish census of pools is trend in nature and will become more meaningful after several years of observations have been accumulated.

Keeler Creek has historically supported large runs of Dolly Varden. These fish are thought to originate from Bull Lake with the adults migrating out of Bull Lake downstream to Keeler Creek and then ascending Keeler Creek to spawn. The smolts migrating from Keeler Creek would naturally follow the same route only in reverse. The fish trap was installed near the mouth of Keeler Creek on June 17, 1977 and removed on October 26, 1977 (Table II-24). During this 102 day period the trap was operated 87 days. Only 11 adult Dolly Varden were captured in the trap. These fish averaged 23.6 inches in length, with the largest fish being 27.5 inches long and weighing 7.75 pounds. The number of fish collected was much less than expected and it appears that a number of fish moved upstream prior to the trap installation. Recent surveys in the North Fork of the Flathead River indicated that significant numbers of Dolly Varden migrated into spawning tributaries prior to mid June when fish traps were installed (personal communication, Joe Huston). A similar situation occurred in Keeler Creek as anglers reported catching untagged adult Dolly Varden above the Keeler Creek trap.

Table II-23 Underwater fish census from pools in Camp Creek and Little Joe sections of Lake Creek, August, 1977

Number Pools Surveyed	Number trout 4 - 10" in Length BT	Number trout 4 - 10" in Length RB	Number over 10" BT	Number over 10" RB	Totals BT	Totals RB
Camp Creek section						
17		8		11		19
Little Joe section						
22	2	24	1	12	3	36

Table II-24 Summary of Keeler Creek trap data - June 17 - October 27, 1977

Number Dolly Varden caught	Average Length in Inches	Average Weight in Pounds	Largest Fish Length	Largest Fish Weight	Days Trap Operated
11	23.6	4.58	27.5	7.75	87

Several more years of baseline data are needed to determine the magnitude of this run and its significance to the Bull Lake fishery.

Fishing pressure estimates for Lake Creek in the 1968 and 1976 fishing seasons were 628 and 794, man-days, respectively. The catch rates ranged from 1.35 fish per hour from 1965-1971 to 2.60 fish per hour in 1976 (Table II-25). These catch rates are above the state average and are indicative of a high quality trout fishery.

Table II-25 Summary of fishing pressure estimates and fisherman's log catch data from Lake Creek

Fishing Season	Fishing Pressure Estimates in Man-days
1968	628
1975	794

Catch Data

	Number	Catch Per	Species Composition of the Catch			
Year	Man-days	Hour Effort	Rainbow	Cutthroat	Dolly Varden	Brook Trout
65-71	14	1.35	28.1	62.5	9.4	
1976	12	2.60	61.7	10.0	1.6	26.7

(3) Heavy Metals Concentration in Fish Tissue

The concentrations of heavy metals in fish flesh collected from Lake Creek and Stanley Creek are in general well below standards set by the USFDA and the Canadian Food and Drug Directorate as safe for human consumption and the concentrations are comparably to those found in the Montana Streams. The data indicates that heavy metals are not limiting fish production in the Lake and Stanley Creek drainages at this time.

The results of the heavy metal analysis of fish flesh are summarized in Tables II-26 and II-27. The heavy metals concentrations are in some instances quite variable among the fish collected from the same sections. Slimy sculpins tended to have higher concentrations of iron and copper than the other species collected. The whole fish was used for the sculpin analyses and internal organs have higher concentrations of heavy metals than the muscle tissue. The variability among fish of the same species did not appear to be a function of fish size; Dent (1975), Van Meter (1974) and Knudson, et. al. (1975) also found a considerable amount of variation in the concentrations of heavy metals in fish tissues from fish collected in the same sample.

Table II-26 Heavy metals concentrations (ug/gm) in fish flesh from Lake Creek and Stanley Creek, August 1977. Fish flesh was used for all species except sculpins where the whole fish was used

Lake - Little Joe section

Species	Length	AG	FE	CU	ZN	PD	HG
Rainbow Trout	210 mm	5.0	37.4	1.0	19.2	5.0	.0005
Rainbow Trout	414 mm	5.0	51.2	1.0	16.3	5.0	.0005
Rainbow Trout	120 mm	5.0	36.3	4.2	115	5.0	.0005
Brook Trout	230 mm	5.0	24.9	1.0	16.3	5.0	.0005
Brook Trout	163 mm	5.0	27.1	1.0	19.2	5.0	.0005
Slimy Sculpin	25 mm	5.0	843	45.1	78.9	5.0	.0005

Lake Creek - Camp Creek section

Species	Length	AG	FE	CU	ZN	PB	HG
Rainbow Trout	400 mm	5.0	31.3	21.7	20.5	8.8	
Rainbow Trout	202 mm	5.0	24.9	1.7	18.9	5.0	.0005
Rainbow Trout	127 mm	5.0	27.1	1.0	21.0	5.0	.0005
Brook Trout	140 mm	5.0	37.4	4.9	34.1	5.0	.0005
Slimy Sculpin	30 mm	5.0	141	62.6	1.2	5.0	.0005

Stanley Creek

Species	Length	AG	FE	CU	ZN	PB	HG
Cutthroat Trout	235 mm	5.0	79.3	1.7	24.1	5.0	.0005
Cutthroat Trout	173 mm	5.0	31.7	1.0	36.6	5.0	.0005
Cutthroat Trout	166 mm	5.0	30.6	1.0	25.8	5.0	.0005
Cutthroat Trout	64 mm	5.0	119	8.4	93.2	5.0	
Brook Trout	135 mm	5.0	75.6	24.2	39.6	8.8	.0005
Slimy Sculpin	31 mm	5.0	64.6	10.0	33.2	5.0	.0005

Table II-27 Average concentrations (mg/gm) of heavy metals in fish tissue collected from Lake Creek and Stanley Creek, August 1977. Fish flesh was used for all species except sculpins where the whole fish was utilized

		Heavy Metals Concentration					
Species	Number of Fish	AG	FE	CU	ZN	PB	HG
		Lake Creek					
RB	6	5.0	34.7	5.1	35.5	5.0	.0005
BT	3	5.0	29.8	2.3	23.2	5.0	.0005
Sculpin	2	5.0	492	53.9	40.5	5.0	.00012
		Stanley Creek					
CT	4	5.0	65.2	3.0	44.9	5.0	.0005
BT	1	5.0	75.6	24.2	39.6	8.8	.0005
Sculpin	1	5.0	64.6	10.0	33.2	5.0	.0005

The use of two different techniques for determining the heavy metals concentration in fish flesh made it difficult to compare the results of this study with results from other areas. The main discrepancy occurred between these studies using wet weight for analyses versus those studies using dry weight. The concentration of heavy metals using the dry weight method are generally about four times higher than those recorded by the wet method (Knudson ibid.).

(a) Silver

In nature silver is found in the elemental state and combined in ores. Most silver salts are insoluable. Silver ions do not occur in significant concentrations in most natural waters. However silver nitrate is highly soluable and silver sulfate is moderately so. Doudoroff and Tatz (1953) found that silver nitrate killed salmon fry within 48 hours at concentrations of less than 0.04 mg/1.

The concentrations of silver in the test fish from Lake Creek and Stanley Creek were below the detectable levels (5.0 ppm).

(b) Iron

Iron concentrate were generally high in all species at all stations with trout from Stanley Creek having the highest concentrations. A sculpin in the Little Joe section of Lake Creek had a concentration of 843 U/gm which is quite high. Iron is part of the enzyme structure and consequently tends to accumulate more in fish tissue than other heavy metals. The concentrations found in the Lake Creek drainage were lower than recorded for the streams from the Stillwater drainage (Knudson ibid.).

Iron can be very toxic to life in aquatic systems such as Lake Creek which have low buffering capabilities. If the receiving water is not strongly buffered the addition of a soluble iron salt may lower the pH of the water to toxic level. Minkina (1950) found that 0.2 mg/1 is the threshold concentration for lethality to three fish species.

(c) Copper

Copper can be quite toxic to aquatic life in poorly buffered systems such as Lake Creek. McKim and Benart (1970) found that the maximum acceptable toxicant concentrations of copper for brook trout was about 17 ug/liter in water with a hardness of 45 mg/liter (as $CaCO_3$). The Canadian Food and Drug Directorate has set a tolerant limit of 100 ug/gm wet weight of copper as unsafe for human consumption (Uthe and Bligh 1971). Copper concentrations in trout were generally low except for one brook trout from Stanley Creek. The copper concentrations in the trout were comparable with those recorded by Van Meter (1974) and Dent (1975) in the Clark Fork River. The concentrations of copper in sculpins were much higher than recorded for trout. The concentrations of copper in all fish appeared to be less than recorded by Stearns-Roger (1975) in Lake Creek.

(d) Zinc

Zinc is quite toxic to fish and aquatic organisms in soft of poorly buffered waters. The sensitivity of fish to zinc varies with species, age and condition of the fish as well as with the physical and chemical characteristics of the water. Affleck (1952) found that 0.04 mg/l of zinc prevented the hatching of rainbow trout eggs. The Canadian Food and Drug Directorate had set a tolerance of 100 ug/g in fish flesh as unsafe for human consumption (Uthe ibid.).

Zinc concentrations in fish tissue collected from both Lake Creek and Stanley Creek average 36.1 ug/g. Zinc is part of the enzyme structure and therefore, tends to concentrate in fish tissue more than most other heavy metals. The zinc concentrations recorded from fish in Lake Creek and Stanley Creek compare favorably with those recorded from other Montana Streams (Dent 1974 and Knudson 1975) but are less than recorded for Lake Creek and Stanley Creek (Stearns-Rogers 1975).

(e) Lead

Lead may be toxic to aquatic life in soft waters such as Lake Creek and Stanley Creek. Halcombe, et. al. (1976) concluded that the maximum acceptable toxicant concentration for brook trout in water with a hardness of 44 mg/liter (as CaC03) lies between 58 119 ug/liter for total lead and between 39 and 84 ug/liter for dissolved lead.

Lead concentrations were below the detectable limit (5.0 ug/g) mall fish except in brook trout from Stanley Creek. The results were comparable to those recorded by Stearns-Rogers (1975). The Canadian Food and Drug Directorate has set a tolerance limit of 10 ug/gm wet weight for lead on fish flesh (Uthe ibid.).

(f) Mercury

Mercury ions are considered to be highly toxic to fish. Doudoroff (1957) found that concentrations of betweens .004 to 0.02 mg/l mercury in water are harmful to aquatic life. The USFDA guideline is that concentration higher than 0.5 ug/gm in fish flesh are unsafe for human consumption. The concentration of mercury in the fish collected in this study and in the Stearns-Rogers Study (1975) were well below the USFDA guidelines.

(4) Bioassay (in situ)

An *in situ* fish bioassay using fingerling cutthroat trout was conducted from October 18 through October 21, 1977 at or near water quality stations NAD, SC1, SC3 and LC2 (Figure II-1). Details of the methods and results are included in Appendix N. Briefly only one mortality was recorded at the four sites over the 65 hour period, that mortality occurring at SC3. One may conclude from this test that there was nothing in the water at these sites, including the exploratory adit discharge, that was acutely toxic to cutthroat trout over the duration of the bioassay. No conclusions can be made regarding chronic effects, however. *In situ* bioassays using similar methods should be rerun at these same stations during construction and operation of the ASARCO facilities.

3. Terrestrial Fauna

In 1973 ASARCO Inc. enlisted Stearns-Roger Inc., Denver, Colorado, to prepare an environmental baseline survey for the proposed Troy Project development. Stearns-Roger inturn subcontracted the terrestrial wildlife portion of the survey to a private consulting organization who prepared a statement and returned it to Stearns-Roger in November 1974. Due to vagueness and inconsistencies in the Stearns-Roger report, state officials requested that another more comprehensive and concise survey be conducted for the proposed ASARCO copper-silver mine development which would meet the requirements of the Montana Environmental Policy Act (MEPA).

Objectives set forth for the new more comprehensive survey were as follows:

1) to obtain an inventory of fish and wildlife species inhabiting an expanded study area and provide additional updated inventory information for those species inhabiting the original Stearns-Roger study area,

2) to obtain additional information for an expanded study area on the relative abundance of the major and ecologically important species,

3) to relate the various species present to the habitat types on which they are dependent,

4) to update and provide additional information for an expanded study area on the relative abundance of the major and ecologically important species, and

5) to use updated and supplementary inventory data for an evaluation of the potential faunal impacts from the proposed mine and associated facilities, as well as the potential of mitigating or compensating for faunal impacts.

Unless data were in conflict or were unique to the Stearns-Roger study, comparisons are not made between the 1973-1974 survey and the expanded 1977-1978 survey. Site specific information for each observation or incidence of sign recorded during this study is presented in Joslin (1978).

The wildlife inventory of terrestrial fauna other than endangered or threatened species was conducted from April 1977 through March 1978 (Joslin, 1978). Spring was considered the months of April, May and June; summer included July, August and September; fall included October, November and December, and winter included January, February and March. Due to the variety of wildlife species being investigated, study area boundaries remained flexible to accommodate individual species investigation. The extensive area covered roughly 425 km2 (165 mi2), and was approximated by the Montana-Idaho border to the west, Highway 202 to the east, Callahan Creek to the north and Dry Creek to the south (Figures 1-18).

More than 35 on-foot trips were made into roadless portions of the ASARCO copper-silver mine study area, all drivable roads were covered at least once and 19 aerial surveys were conducted during the study. Six cover types were recognized during the wildlife inventory on the study area including: water, shore, shrubs, cutting units, open areas and forest. Open areas included artificial openings (pasture, croplands, and residential area) and natural openings (talus, meadows, sidehill parks and burns). Forested areas were classified as forested habitat types according to Pfister et. al. (1977). Abbreviations and full scientific and common names of forest habitat types are given in Table II-9 . Elevation is given in meters (m) and general aspect (direction) is defined as north, northeast, east, southeast, south, southwest, west, northwest and flat.

a. Herpetofauna

Observations of herpetofauna were collected incidental to other activities and were recorded according to month, cover type and habitat type. Four species of reptiles and four species of amphibians were observed on the study area and are presented in Table II-28.

Table II-28 Amphibian and reptile observations recorded on the ASARCO copper-silver mine study area from April 1977 through March 1978

		COVER TYPES						HABITAT TYPES[1]							
COMMON NAME	SCIENTIFIC NAME	WATER	SHORE	SHRUBS	OPEN AREAS	CUTTING UNITS	FOREST	TSUGA-THUJA SERIES	THPL/OPHO	THPL/CLUN	TSHE/CLUN	ABIES GRANDIS SERIES	ABGR/CLUN	ABIES LASIOCARPA SER.	ABLA/CACA
Tailed Frog	Ascaphus truei	x													
Western Toad	Bufo boreas	x					x		x		x				
Pacific Tree-frog	Hyla regilla				x	x	x			x	x				
Spotted Frog	Rana pretiosa	x		x			x		x					x	
Painted Turtle	Chrysemys picta	x													
Rubber Snake	Charina bottae						x					x			
Common Garter Snake	Thamnophis sirtalis						x				x				
Western Garter Snake	Thamnophis elegans						x				x				

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[1] Habitat types according to Pfister et. al. 1977. See Table II-9 for full scientific and common names.

The tailed frog (Ascaphus truei) is classified as a "nongame species of special interest or concern" by the Montana Department of Fish and Game (Flath, 1977). This species is restricted to well forested areas in the vicinity of cold mountain streams having a rocky streambed (Stebbins, 1954). The tailed frog was observed in Stanley Creek in the immediate vicinity of the proposed ASARCO mine main entrance adit on August 2, 1977.

Except for the rubber snake (Charina bottae) all observed herpetofauna were confined to moist areas. The rubber snake was located at 1220 m (4000 ft) on top of Stanley Mountain in the ABGR/CLUN habitat type.

The wood frog (Rana sylvatica) was not observed during this study period but was noted on the area by Stearns-Roger (1975) and constitutes a unique observation because this species is not considered to be present in this area (Stebbins, 1966).

A total of nine species of herpetofauna have been documented on the study area to date and Flath (Montana Department of Fish and Game, pers., com.) indicates that the very rare Coeur d'Alene salamander (Plethodon vandykei) has been collected from the vicinity of Lake Creek. Stebbins (1966) indicates that the leopard frog (Rana pipiens), western skink (Eumeces skiltonianus), northern alligator lizard (Gerrhonotus coeruleus), racer (Coluber constrictor) and gopher snake (Pituophis catenifer) may also occur in this area.

b. Birds

All avian species observed on the study area were recorded by date, cover type, habitat type and location. The scientific names, monthly occurrence, cover type, and habitat type utilization for 112 species of birds observed on the ASARCO copper-silver mine study area from April 1977 through March 1978 are given in Appendix O.

(1) Waterfowl

Twenty species of waterfowl were observed on the study area and included ducks, geese, swans, loons, herons and grebes. Several of the ponds and marshes surrounding Bull Lake and Lake Creek were surveyed for waterfowl and Lake Creek was floated with a rubber raft on July 11 from the mouth of Bull Lake, 16 km (10 mi) north to the bridge near Felix Creek. Bull Lake was inventoried on July 14 with a jet boat. Swamps and marshes surrounding Bull Lake and Lake Creek were surveyed for waterfowl broods and observations were also recorded incidental to other activities.

Waterfowl habitat on the study area is primarily confined to Bull Lake and Lake Creek where 90 percent of the waterfowl observations occurred. Observations were also recorded on Stanley Creek and on the ponds and marshes located in the main Lake Creek Valley. Waterfowl utilization was also noted on the pond near Camp Creek which is proposed to be inundated by the ASARCO tailing impoundment.

Brood information was collected on three of the nine species of ducks observed (Table II-29). Of the 20 duck broods recorded, 11 were common merganser (*Mergus merganser*), eight common goldeneye (*Bucephala clangula*) and one mallard (*Anas platyrhynchos*). Ring-necked ducks (*Aythya collaris*) and blue-winged teal (*Anas discors*) may have also nested on the study area because lone drakes of these species were observed as late as June (Appendix O). Observations of lone drakes during the nesting season usually indicates the drakes have recently deserted the inhabiting hens (Dzubin, 1969). Ducks observed primarily during spring and fall migration included: pintail (*Anas acuta*), green-winged teal (*Anas crecca*), cinnamon teal (*Anas cyanoptera*), American wigeon (*Anas americana*), Barrow's goldeneye (*Bucephalaislandica*), hooded merganser (*Lophodytes cucullatus*) and bufflehead (*Bucephala albeola*). Although broods were not observed, these species have been known to breed in this region of the state (Skaar, 1975).

Waterfowl, other than ducks, which were observed during the report period included: common loon (*Gavia immer*), red-necked grebe (*Podiceps grisegena*), horned grebe (*Podiceps auritus*), western grebe (*Aechmophorus occidentalis*), pied-billed grebe (*Podilymbus podiceps*), whistling swan (*Olor columbianus*), Canada goose (*Branta canadensis*) and great blue heron (*Ardea herodias*). These speicies were observed during spring and fall migration except the great blue heron which was observed from April through November and again in March. Although evidence of breeding on the study area was not confirmed during the report period, Skaar (1975) indicates that these species, except the whistling swan, breed in this region of the state.

(2) Raptors

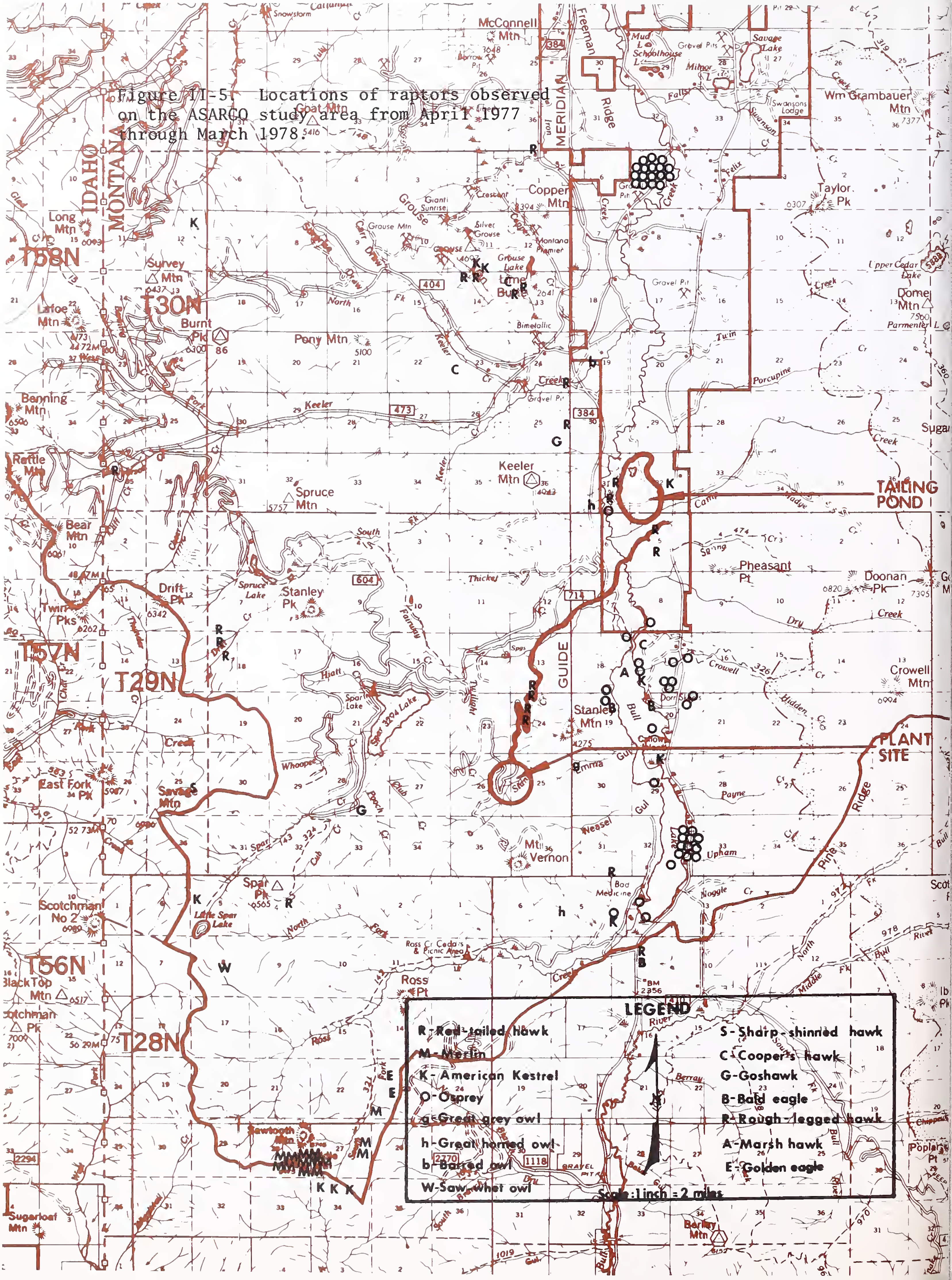
Fifteen species of raptors were observed during the report period and included accipiters, falcons, harriers, eagles, buteos, owls and ospreys (*Pandion haliaetus*). Observations of raptors (Figure II-5) were made incidental to other activities except for the osprey, for which efforts were directed specifically towards locating and monitoring nests.

The osprey was the most commonly observed raptor during the study followed by the red-tailed hawk (*Buteo jamaicensis*), 22 observations; the American kestrel (*Falco sparverius*), 15 observations and the merlin (*Falco columbarius*), 14 observations. These species were observed during the summer (breeding) period (Appendix O). Although breeding evidence was collected only for the osprey, Skaar (1975) indicates that hard evidence of breeding (active nest or dependent young) has been collected for the red-tailed hawk and American kestrel and circumstancial evidence has been collected for the merlin in this part of the state. The red-tailed hawk, merlin (pigeon hawk) were observed primarily in open areas, or cutting units (Appendix O). Due to observability in open areas these raptors may not have been more abundant than the forest

Table II-29 Duck broods observed on the ASARCO copper-silver mine study area during Summer 1977

DATE	SPECIES	BROOD SIZE	LOCATION ¼	¼	S	T	R	AREA
6-12	Common Goldeneye	2	NW	SE	20	29N	33W	Swamp NE edge Bull Lake
6-12	Common Goldeneye	4	NE	SE	20	29N	33W	Swamp NE edge Bull Lake
6-12	Common Goldeneye	1	NE	SE	20	29N	33W	Swamp NE edge Bull Lake
6-16	Common Goldeneye	10	NE	SW	4	28N	33W	Swamp NE edge Bull Lake
6-16	Common Goldeneye	7	NE	NE	31	30N	33W	Pond N of Camp Creek
6-19	Common Goldeneye	3	NE	SW	20	29N	33W	Swamp E edge of Bull Lake
6-19	Common Goldeneye	3	NE	SW	20	29N	33W	Swamp E edge of Bull Lake
7-11	Common Merganser	6	SW	SW	20	30N	33W	Lake Creek near Twin Creek
7-11	Common Merganser	5	SW	NW	20	30N	33W	Lake Creek at Keeler Creek
7-11	Common Merganser	6	SE	SW	17	30N	33W	Lake Creek at Keeler Creek
7-11	Common Merganser	6	SE	NW	17	30N	33W	Lake Creek N of Keeler Creek
7-11	Common Merganser	7	NW	NW	17	30N	33W	Lake Creek S of Copper Creek
7-11	Common Merganser	6	SE	SE	7	30N	33W	Lake Creek N of Copper Creek
7-11	Common Merganser	7	NE	NW	8	30N	33W	Lake Creek N of Chase Cut-off
7-11	Common Merganser	8	SW	SE	5	30N	33W	Lake Creek S of Felix Creek
7-13	Common Goldeneye	6	NE	SW	4	28N	33W	South end of Bull Lake
7-13	Common Merganser	9	SW	NW	29	29N	33W	Middle of Bull Lake
8-12	Common Merganser	8	NE	NE	19	29N	33W	West shore of Bull Lake
8-12	Mallard	4	SW	SW	20	29N	33W	West shore of Bull Lake
8-12	Common Merganser	6	SW	NE	19	29N	33W	West shore of Bull Lake

Figure II-5. Locations of raptors observed on the ASARCO study area from April 1977 through March 1978.



dwelling raptors, rather they were easier to observe. Raptors observed in the study area whose habitat is confined primarily to dense forests included: goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), saw-whet owl (*Aegolius acadicus*) and great gray owl (*Strix nebulosa*) (Appendix Table O). Raptors which were observed in the timber but were not necessarily confined to timber included: Cooper's hawk (*Accipiter cooperii*), great horned owl (*Bubo virginianus*) and barred owl (*Strix varia*). There have been less than 10 sightings of the barred owl in Montana (Skarr, 1975) and the one observed during this study was a road kill found along Keeler Creek.

The bald eagle (*Haliaeetus leucocephalus*) was classified as an endangered species in February 1978 by the U. S. Fish and Wildlife Service. Three sightings of the bald eagle were made during April and November, 1977 and February, 1978. These birds were observed near Bull Lake and their occurrence there is probably related to migrating waterfowl which use the lake prior to freeze-over and after break-up. The golden eagle (*Aquila chrysaetos*) was observed on two occasions in the South Fork of Ross Creek near the head of Dry Creek (Figure II-5). The marsh hawk (*Circus cyaneus*) and rough-legged hawk (*Buteo lagopus*) were also observed but their use of the area is probably limited to spring and fall migration. Evidence suggests the occurrence of peregrine falcons (*Falco peregrinus*) in the area (Skaar, 1975 and Robbins, et. al. 1966).

The osprey, primarily a fish-eater, was the most commonly observed raptor on the study area. It was estimated that 48 observations were of a minimum of 13 individuals. Table II-30 gives the locations of nine osprey nests noted on the study area. Nests 1, 2 and 3 were each attended by a pair of adults who incubated and successfully hatched young during 1977. Nests 1 and 3 fledged two young each during the first week in August. Nest 2 was abandoned in early July shortly after logging activities commenced in the immediate area. The fate of these birds is unknown, but no adults or young osprey were observed at or near this nest after July. Osprey were not observed on Nest 4 by the investigator but reports indicate this nest was attended by a pair early in the season. The birds on this nest were reported by locals to have been shot. Ospreys were reported during previous years on Nest 5, but this nest was not attended during 1977. Nests 6, 7 and 8 by their location and construction indicate previous use by osprey but none was observed near the nest in 1977. Nest 9 was located during March 1978 and was in good repair.

(3) Forest Grouse

Members of the family Tetranonidae which were observed on the ASARCO copper-silver mine study area included: blue grouse (*Dendragapus obscurus*), ruffed grouse (*Bonasa umbellus*) and spruce grouse (*Canachites canadensis*). These grouse are all native to Montana and are generally

Table II-30 Osprey nests located on the ASARCO copper-silver mine study area during 1977 - 1978 including first observation dates, site description and comments

NEST NO.	DATE LOCATED	SITE DESCRIPTION	COMMENTS
1	5-18-77	East shore of Bull Lake along Highway 202. Top of partially dead larch (*Larix occidentalus*) tree.	Productive nest - two young fledged first week of August.
2	6-16-77	Crowell Creek. Tree standing in dry creek bed. Top of dead larch tree. Within 0.4 Km of Bull Lake.	Nest failure - young abandoned in early July, coincident with initiation of logging activity beneath nest.
3	6-15-77	Freeman Ridge, across from Felix Creek. Top of giant larch snag. Within 0.4 Km of Lake Creek.	Productive nest - two young fledged first week of August.
4	6-19-77	Swanson Creek. Top larch snag. Next to swamp, 0.8 Km from Lake Creek.	Unoccupied nest, may have had osprey pair earlier in Spring. Pair is reported to have been shot off nest.
5	7-14-77	Noggle Creek. Top of larch snag. Near ponds, about 1.5 Km from Bull Lake.	Unoccupied nest.
6	7-14-77	West shore of Bull Lake near Emma Gulch In dead larch snag.	Unoccupied nest.
7	4- 9-77	East shore of Bull Lake near Crowell Creek in broken spruce (*Picea* sp.) snag.	Unoccupied nest.
8	5-16-77	Northwest of Little Spar Lake. Top of dead unidentified tree.	Unoccupied nest. Observed from the air. No osprey were observed from the ground in this vicinity.
9	3-12-78	Northwest of Schoolhouse Lake. Top of dead unidentified snag.	Fate of this nest unknown during 1977.

limited to the mountainous regions of the state. Observations and sign of blue grouse and ruffed grouse recorded during the study are contained in Joslin (1978). The distribution of these observations and the observations of spruce grouse are presented in Figure II-6. The blue grouse and ruffed grouse data is summarized in Tables II-31 and II-32, respectively.

The three observations of spruce (Franklin's) grouse recorded on the study area occurred near Camp Creek in the area proposed to be inundated by ASARCO's tailing impoundment. The overall geographic distribution of the spruce grouse is a transcontinental band generally conforming to the boreal coniferous forest (Aldrich, 1963). In Montana, spruce grouse are more limited in their range than either the blue or ruffed grouse and are generally found in the denser forest types such as subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*) or lodgepole pine (*Pinus contorta*) in western Montana (Mussehl, et. al. 1971).

Blue grouse are present in 12 western states and four Canadian provinces (Aldrich, 1963). The overall range of the species is closely associated with the distribution of true fir (*Abies*) and especially Douglas-fir (*Pseudotsuga menziesii*) (Beer, 1943). In Montana they are found in the coniferous forests of the west and in isolated mountain ranges east of the divide (Mussehl, et. al. 1971). In contrast to the ruffed grouse, which are generally sedentary year-round (Gullion, 1967), blue grouse usually move to higher elevations in fall, spend the winter there, and return to lower areas in spring to breed and raise young (Zwickel, et. al., 1968, Mussehl, 1960 and Bendell and Elliott, 1967).

During the report period, 57 observations of blue grouse were recorded (Table II-31). Eighty-three percent of blue grouse observations were recorded at 1280 m (4200 ft) and above, with all observations between 914 m (3000 ft) and 1830 m (6000 ft). Blue grouse were found in 12 habitat types (Appendix O). Sixty-one percent of the observations occurred in subalpine fir habitat types (ABLA/XETE, ABLA/LUHI, ABLA/MEFE and ABLA/CACA) and 22 percent in Douglas-fir habitat types (PSME/SYAL, PSME/PHMA and PSME/AGSP).

The ruffed grouse is the most widely distributed of all native American Tetraonidae (Aldrich, 1963). They are currently residents of 38 states and 13 Canadian provinces or territories (Gullion, 1977). In Montana, ruffed grouse are found primarily west of the Continental Divide and in the scattered mountains and associated drainages of Central Montana east of the divide (Mussehl, et. al. 1971).

Although ruffed grouse are widely distributed, the unifying criterion, is that successional or climax vegetation stages include deciduous trees, especially of the genera *Betula* and *Populus* (Johnsgard, 1973). Gullion (1969) indicates that on a continent-wide basis, the highest population densities of ruffed grouse correspond to the distribution patterns of aspens (*Populus* spp.). Aspen is important winter and summer food for adults and provides valuable brooding habitat. On the ASARCO copper-silver mine study area three specis of *Populus* were noted including quaking aspen (*Populus tremuloides*), black cottonwood (*Populus*

Table II-31 Blue Grouse Sex and Age Classification according to month on the ASARCO copper-silver mine study area from April 1977 through March 1978

	A	M	J	J	A	S	O	N	D	J	F	M	TOTAL
Males	-	1	1	-	1	-	1	-	-	-	-	-	4
Females	-	-	5	1	4	-	-	-	-	-	-	-	10
Adults	-	1	-	2	11	-	2	-	-	-	-	1	17
Unclassified	-	-	-	-	-	-	1	-	-	-	-	-	1
Number Broods	-	-	-	1	6	-	-	-	-	-	-	-	7
Number Young	-	-	-	1	24	-	-	-	-	-	-	-	25
Average Brood Size	-	-	-	1.0	4.0	-	-	-	-	-	-	-	3.6
TOTAL	-	2	6	4	40	-	4	-	-	-	-	1	57

Table II-32 Ruffed Grouse Sex and Age Classification according to month on the ASARCO copper-silver mine study area from April 1977 through March 1978

	A	M	J	J	A	S	O	N	D	J	F	M	TOTAL
Males	9	9	1	-	3	4	1	-	-	-	-	-	27
Females	4	2	2	2	3	-	-	-	-	-	-	-	13
Adults	1	2	-	1	1	1	-	-	-	-	-	-	6
Unclassified	-	-	-	-	-	4	7	3	5	3	-	-	22
Number Broods	-	-	1	1	6	-	-	-	-	-	-	-	8
Number Young	-	-	3	8[1/]	36	3	-	-	-	-	-	-	50
Average Brood Size	-	-	3.0	5.0	6.0	-	-	-	-	-	-	-	5.9
TOTAL	14	13	6	11	43	12	8	3	5	3	-	-	118

[1/] Three young found dead on road. Not counted as brood.

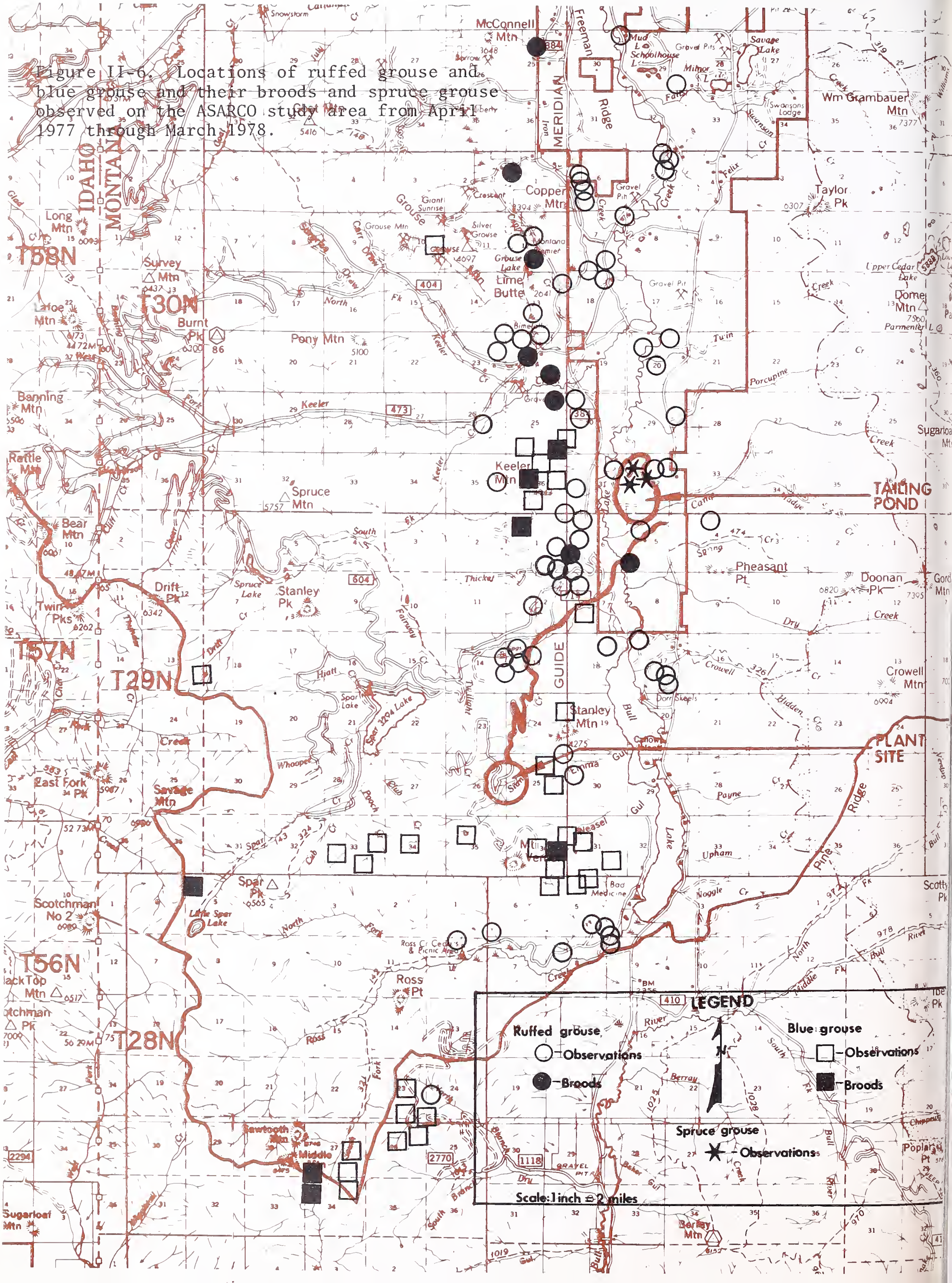


Figure II-6. Locations of ruffed grouse and blue grouse and their broods and spruce grouse observed on the ASARCO study area from April 1977 through March 1978.

trichocarpa) and plains cottonwood (Populus deltoides). Other deciduous trees present on the study area which may be used by ruffed grouse included water birch (Betula occidentalis), paper birch (Betula papyrifera), willows (Salix spp.), mountain alder (Alnus sinuata) and thinleaf alder (Alnus incana).

Drumming countes have been used effectively for obtaining indicies of male ruffed grouse (Dorney, et. al. 1958). Appendix O contains results of two drumming routes conducted on the study area along Stanley and Keeler Creek. These routes were run on clear mornings with wind less than three mph and were usually started one-half hour before sunrise, and had a four minute listening stop (Petraborg, et. al. 1953). Both routes included 15 stops which were 400 m (¼ mi) apart. Information from this study indicates that routes conducted along Stanley and Keeler Creeks during the last 10 days in April and the first 10 days in May will cover the peak of drumming activity in subsequent years.

During the study period, 118 observations of ruffed grouse were made (Table II-32). Ruffed grouse were observed more consistently at lower elevations than blue grouse. Ninety-two percent of the ruffed grouse observations occurred at 830 m (2800 ft) and below, with all observations occurring between 670 m (2700 ft) and 1460 m (4800 ft). Although ruffed grouse were more numerous than blue grouse they were found in fewer habitat types. Eighty-one percent of the ruffed grouse observations occurred in the TSHE/CLUN habitat type and 15 percent occurred in three Douglas-fir types (PSME/PHMA, PSME/CARU and PSME/LIBO).

(4) Shorebirds

Five species of shorebirds were observed during the study. Observations of shorebirds were made incidental to other observations and monthly occurrence of these is given in Appendix O. The spotted sandpiper (Actitis macularia) was the most commonly observed shorebird on the study area and was found utilizing most lakes, ponds and streams. Dependent young of spotted sandpipers were also observed indicating that breeding does occur on the study area. Other shorebirds observed during the study included: common snipe (Capella gallinago), American coot (Fulica americana), killdeer (Charadrius vociferus) and California gull (Larus californicus). The common snipe was observed during the summer months (Appendix O) and although breeding records were not established on the study area, they are known to breed in this region of the state (Skaar, 1975) as are the American coot, killdeer and California gull.

Spotted sandpipers and killdeers were observed foraging on the mudflats of a pond near Camp Creek. This area is located on the site of ASARCO's proposed tailing impoundment.

(5) Other Birds

Birds of the order Passeriformes (perching or song birds) constituted 56 of the 69 birds observed in this category. The other 13 species include: woodpeckers, hummingbirds, belted kingfisher (*Megaceryle alcyon*), rock dove (*Columba livia*), mourning dove (*Zenaida macroura*) and common nighthawk (*Chordeiles minor*). The monthly occurrence of these birds and the cover types and habitat types in which they were observed are given in Appendix O.

Bird observations were collected incidental to other activities, therfore, the number of species observed should be considered a minimum figure. Birds commonly observed in the forest cover type on the study area included: gray jay (*Perisoreus canadensis*), varied thrush (*Ixoreus naevius*), golden-crowned kinglet (*Regulus satrapa*), dark-eyed junco (*Junco hyemalis*) and chipping sparrow (*Spizella passerina*). Birds which were regularly observed in cutting units were: Lewis' woodpecker (*Asyndesmus lewis*), olive-sided flycatcher (*Nuttallornis borealis*) and mountain bluebird (*Sialia currucoides*). Birds which were consistently observed in either the shrub or forest cover type were: song sparrow (*Melospiza melodia*), Steller's jay (*Cyanocitta stelleri*), Swainson's thrush (*Catharus ustulatus*) and black-capped chickadee (*Parus atricapillus*). Species which did not appear to be limited to a specific cover type included: rufous hummingbird (*Selasphorus rufus*), common flicker (*Colaptes auritus*), common raven (*Corvus corax*) and common crow (*Corvus brachyrhynchos*). Dippers (*Cinclus mexicanus*) were observed along most streams and the winter wren (*Troglodytes troglodytes*) was commonly observed in dense forests along streams.

Nearly all observations of mountain bluebirds were made at the site of the proposed tailings pond where the open area, abundance of perches and availability of old woodpecker holes or natural cavities for nesting (Jackman and Scott, 1975) provide critical habitat. Woodpeckers were also commonly observed in this area and along Stanley Creek where feeding and nesting trees were common. A commensalistic relationship exists between the mountain bluebird and woodpeckers because old woodpecker holes are usually used for nesting purposes by mountain bluebirds (Jackman and Scott, 1975). Power (1966) notes that "Highly specialized nesting requirements have produced a relatively unadaptable species whose population has declined as a result of environmental changes of recent decades".

c. Mammals

Information collected for each mammalian observation or incidence of sign included date, time of day and location. Each observation or report of sign was recorded according to cover type and habitat type (if cover type happened to be timber, or the nearest adjacent habitat type). Slope (in degrees) general aspect, topography (ridge, upper slope, mid-slope, lower slope, bench or flat and creek bottom) and configuration (lay of the land described as convex, straight, concave or undulating) were noted for each observation or instance of sign (Joslin, 1978). Distance to cover (vegetation capable of concealing an animal) and distance from the nearest drivable road were estimated for each observation in the following increments: 1-10 m, 50-100 m, 100-200 m and over 200 m. Observations were made using a 7 X 35 or 6 X 28 binocular and a 15-60 variable power spotting scope.

(1) Rodent-like Mammals

The 14 rodent-like mammal species observed during this study were divided into three categories: shrews, rodents and hare and pika (*Ochotona princeps*). Table II-33 indicates that observations or sign of these species were noted in six different cover types and in several different habitat types on the study area. Most observations were collected incidental to other activities although five species were captured and identified using 13 snap-trap trap lines.

Small mammal trap lines were set according to techniques adapted from Calhoune (1948). Five lines were established during the spring period while the same five lines and an additional three lines were set in fall (September). Locations and descriptions of each line are given in Appendix O. Results of the spring and fall trapping are presented in Table II-34. Five trap lines were established at proposed mine facility sites including the tailings pond, well and substation, clarification pond, lower mill and upper mill sites. Plans for the clarification pond have since been deleted by ASARCO and this site represents an undisturbed TSHE/CLUN habitat type. The other four sites have been logged to various degrees. Three additional lines established during September were located in habitat types proposed for mining disturbance. Trapping success was in all cases better during the fall than during the spring. More small mammals were captured at the most recently disturbed sites and the more moist undisturbed sites than were captured at the old disturbed and drier undisturbed sites.

Table II-33 Rodent-like mammals observations and sign according to cover type and habitat type recorded on the ASARCO copper-silver mine study area from April 1977 through March 1978

		COVER TYPES						HABITAT TYPES[1]											
COMMON NAME	SCIENTIFIC NAME	WATER	SHORE	SHRUBS	CUTTING UNIT	OPEN AREAS[2]	FOREST	TSUGA-THUJA SER.	THPL/OPHO	THPL/CLUN	TSHE/CLUN	PSEUDOTSUGA MENZIESII SER.	PSME/PHMA	PSME/AGSP	ABIES LASIOCARPA SER.	ABLA/XETE	ABLA/MEFE	ABLA/LUHI	ABLA/CACA
Shrews																			
Masked Shrew	*Sorex cinereus*				x		x		x		x						x		
Vagrant Shrew	*Sorex vagrans*				x		x		x		x						x		
Rodents																			
Golden-mantled Squirrel	*Spermophilus lateralis*					x													
Columbian Ground Squirrel	*Spermophilus columbianus*				x	x	x											x	x
Redtail Chipmunk	*Eutamias ruficaudus*						x				x					x	x	x	
Red Squirrel	*Tamiasciurus hudsonicus*						x				x		x	x					
Northern Pocket Gopher	*Thomomys talpoides*					x	x				x		x	x				x	
Beaver	*Castor canadensis*	x	x	x			x		x	x									
Muskrat	*Ondatra zibethica*	x	x																
Porcupine	*Erethizon dorsatum*					x	x				x				x				
Deer Mouse	*Peromyscus maniculatus*				x														
Bushytail Woodrat	*Neotoma cinerea*					x													
Boreal Redback Vole	*Clethrionomys gapperi*				x		x		x		x								
Mountain Phenacomys	*Phenacomys intermedius*						x		x										
Hare and Pika																			
Snowshoe Hare	*Lepus americanus*						x				x								
Pika	*Ochotona princeps*					x													

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[1] Habitat type according to Pfister et. al. (1977). Series name preceeds each set of habitat types. See Table II-9 for full scientific and common names

[2] Open areas include pastures, cropland and natural openings (meadow, parks, talus and burns).

Table II-34 Small mammal trapline results on the ASARCO copper-silver mine study area during Spring and Fall 1977

Trapline Name[1/]	Date	Peromyscus maniculatus		Clethrionomys gapperi		Sorex spp.		Phenacomys intermedius		Total animals	Total Percent Success[2/]
		Male	Female	Male	Female	Male	Female	Male	Female		
Tailings Pond Site	04/29-05/01	2	-	-	-	-	1	-	-	3	2.22
Well and Substation Site	04/30-05/02	1	1	-	-	-	-	-	-	2	1.48
Clarification Pond Site	05/04-05/06	2	-	-	-	-	1	-	-	3	2.22
Lower Mill Site	05/05-05/07	-	3	4	1	-	1	-	-	9	6.67
Upper Mill Site	05/05-05/07	9	5	5	3	-	1	-	1	24	17.78
Subtotals		14	9	9	4	-	4	-	1		
TOTALS		23		13		4		1		41	6.07

Trapline Name	Dates Run	Peromyscus maniculatus		Clethrionomys gapperi		Sorex vagrans		Sorex cinereus		Eutamias ruficaudus		Total animals	Total Percent Success
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		
Tailings Pond Site	09/13-09/15	3[3/]	1	-	1	-	-	-	-	1	1	7	5.19
Well and Substation Site	09/10-09/12	1	2	-	-	-	1	-	-	-	-	4	2.96
Clarification Pond Site	09/08-09/10	4	-	-	-	-	-	-	-	-	-	4	2.96
Lower Mill Site	09/08-09/10	2	3	1	1	1	2	2	7	1	-	20	14.81
Upper Mill Site	09/08-09/10	7	1	8	1	1	-	2	7	-	-	27	20.00
THPL/OPHO	09/12-09/14	8	4	5	4	-	-	1	1	1	-	24	17.78
TSHE/CLUN	09/13-09/15	-	1	-	-	-	2	-	1	2	-	6	4.44
ABLA/MEFE	09/12-09/14	3	4	3	6	1	-	-	1	1	2	21	15.56
Subtotals		28	16	17	13	3	5	5	17	6	3		
TOTALS		44		30		8		22		9		113	10.46

[1/] See Appendix O for site information and location of each trapline

[2/] Number of small mammals captured divided by number of trap nights X 100.

[3/] Sex of one animal not determined.

[4/] Habitat types according to Pfister et al (1977). See Table II-9 for full scientific and common names.

(a) Shrews

The masked shrew (Sorex cinereus) and vagrant shrew (Sorex vagrans) were captured at all eight trapping locations (Table II-34). Although shrews were not identified to species during the spring trapping period, it is felt that these were the species captured at that time. More masked shrews were captured than vagrant shrews although this may have been a factor of trap susceptability or trap location (Appendix O). Similar to the other four species captured in trap lines, shrews were more likely to be captured during the fall than the spring (Table II-34). The greatest number of shrews were captured at the proposed ASARCO upper and lower ore milling sites.

(b) Rodents

The only confirmed observation of a hoary marmot (Marmota caligata) in the Cabinet Mountains was made at the existing north adit of the proposed ASARCO mine during summer, 1976 by W. Ruediger (Kootenai National Forest, Biologist) and G. Brown (Montana Department of Fish and Game, Biologist) on separate occasions. Hoary marmots were not observed during this study although limited time was spent at the adit site looking for them.

Golden-mantled squirrels (Spermophilus lateralis) were associated with talus rock on the south side of Mt. Vernon. Columbian ground squirrels (Spermophilus columbianus) were widely distributed but were most often observed in cutting units, particularly clearcuts near the Camp Creek flood plain (site of ASARCO's proposed tailings pond) and the Stanley Creek clearcuts, a portion of which is proposed for the utility corridor route and the well field and mill water sump. The redtail chipmunk (Eutamias ruficaudus) was universally distributed throughout the study area and the very similar yellow pine chipmunk (Eutamias amoenus) may also occur (Hoffman and Pattie, 1968). Chipmunks were observed in cutting units and in the TSHE/CLUN, ABLA/MEFE, ABLA/LUHI and ABLA/CACA habitat types and were captured in small mammal trap lines at the tailings pond site, lower mill site, THPL/OPHO, TSHE/CLUN and ABLA/MEFE trapping sites. Red squirrels (Tamiasciurus hudsonicus) were universally distributed through the habitat types and in selectively logged cutting units. Northern pocket gophers (Thomomys talpoides) were not observed but their diggings were identified on several occasions in open areas or in the PSME/PHMA, PSME/AGSP and ABLA/LUHI habitat types.

Beaver (Castor canadensis) were observed along the northeast shore of Bull Lake and caches, cuttings, dams, lodges, slides, canals and tracks were observed along Lake and Stanley Creeks (Figure II-7). Three beaver colonies occur at the mouth of Stanley Creek and in the past two colonies

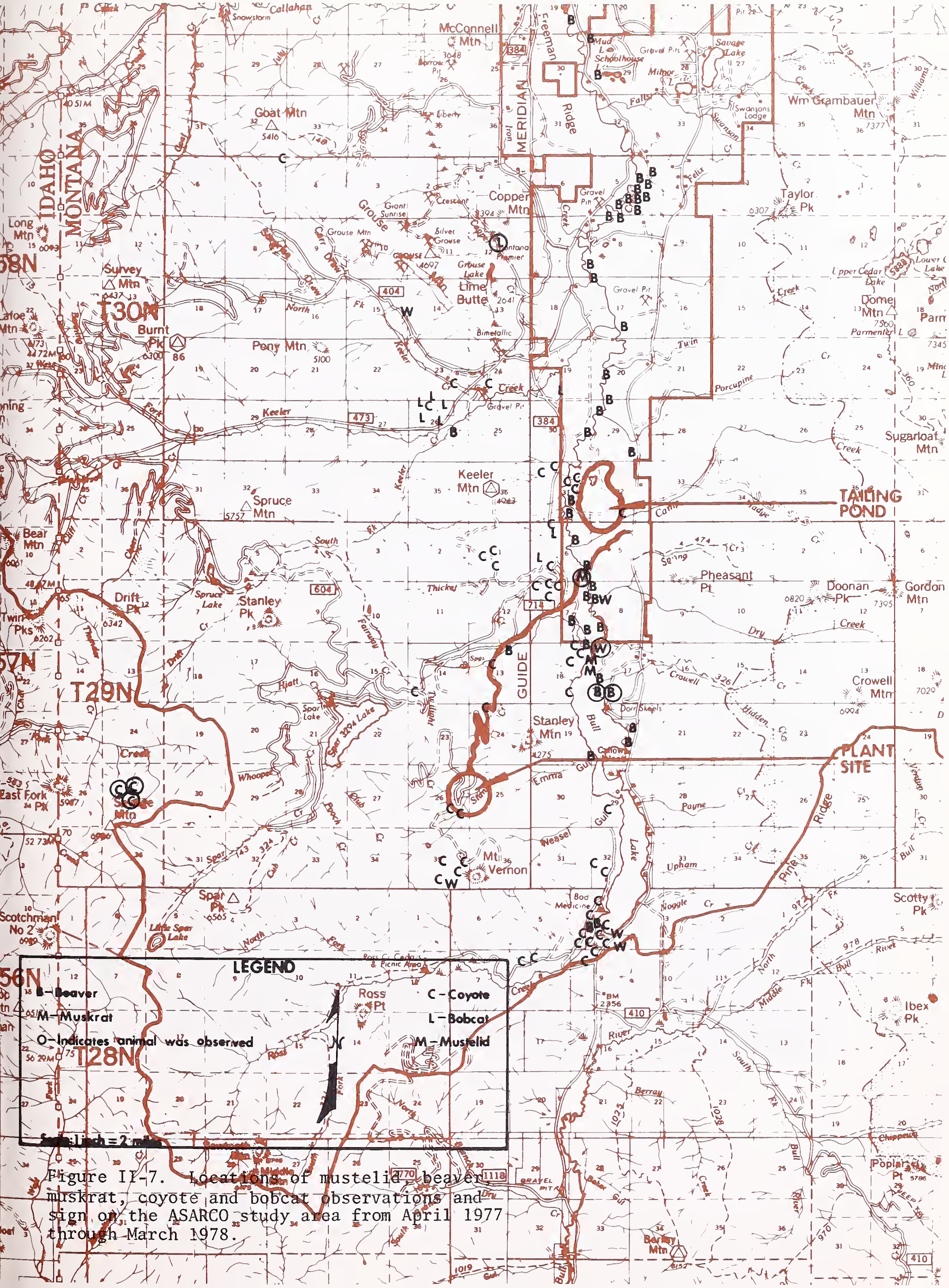


Figure II-7. Locations of mustelid, beaver, muskrat, coyote and bobcat observations and sign on the ASARCO study area from April 1977 through March 1978.

were present below the junction of Stanley and Fairway Creeks (V. Blanchard, trapper, pers. com.). The number of colonies occurring along Lake Creek is not known, although a helicopter reconnaissance during November, 1977 revealed a minimum of 30 caches (K. Knocke, Montana Department of Fish and Game, pers. com.) 13 dams, one lodge, as well as numerous cuttings, canals and slides. Trappers indicate that the beaver population in the area is steady and may be increasing. The beaver in Montana is classified as a furbearer and Mitchell, et. al. (1971) indicates that in the past beaver have accounted for up to 61 percent of the income to Montana trappers.

Muskrat (*Ondatra zibethica*) were observed along Lake Creek near the mouth of Stanley Creek and two muskrat dens were located along the north edge of Bull Lake. Muskrats are particularly susceptible to water level fluctutations (Errington, 1963) and they appear to have suffered a population decline since 1976 due to low water levels during both winter and summer (V. Blanchard and D. Cloin, trappers, pers. com.). The muskrat is also classified as a furbearer in Montana and has provided up to 17 percent of the Montana trapper's average annual income (Mitchell, et. al. 1971).

Two porcupines (*Erethizon dorsatum*) were observed in an open area on Middle Mountain (G. Brown, Montana Department of Fish and Game, pers. com.) within the ABLA series and evidence of porcupine's feeding on conifers in the valley bottom within the TSHE/CLUN habitat type were noted. One bushytail woodrat (*Neotoma cinerea*) was observed on the open rocky ridgetop of Savage Mountain.

Deer mice (*Peromyscus maniculatus*) were the most frequently captured species at all five spring trapping locations and at four of the eight fall trapping locations (Table II-34). Of the six species captured in trap lines, deer mice comprised 43.5 percent of the catch. During both spring and fall the upper mill site trap line showed the highest trapping success with deer mice comprising 58 and 30 percent of the catch for each season, respectively. The THPL/OPHO site had the second highest trapping success with deer mice comprising 50 percent of the total catch. The THPL/OPHO habitat type is present along portions of the proposed tailings slurry pipeline route.

The boreal redback vole (*Clethrionomys gapperi*) was the second most commonly captured species comprising 28 percent of the total catch (Table II-34). The boreal redback vole was the most commonly captured species at the following locations: upper mill site during both the spring and fall, the lower Mill Site during the spring and the ABLA/MEFE site (trapped only during fall). Trapping success at the THPL/OPHO habitat type site revealed it to be as important as each of the previously mentioned sites although it was second to the deer mouse in numbers captured. A single mountain phenacomys (heather vole) (*Phenacomys intermedius*) was captured at the upper mill site during the spring trapping period (Table II-34).

(c) Hare and Pika

Eighty percent of the 45 observations of snowshoe hare (*Lepus americanus*) were made in the Stanley Creek drainage. In all instances they were observed along the road in the TSHE/CLUN habitat type near thick brush (Table II-33). During winter, snowshoe hare tracks occurred throughout the study area with concentrations in Stanley Creek and at the mouth of Keeler Creek.

Pika appeared to occur above 1580 m (5200 ft) wherever scree areas composed of large rocks provided suitable habitat. The rocky pass between Stanley Creek and Emma Gulch was the lowest elevation (1100 m or 3600 ft) at which pika were noted.

(2) Carnivores

Carnivores constitute a varied group of uncommonly observed animals. Sightings or sign of seven species of carnivores were recorded on the ASARCO copper-silver mine study area from April 1977 through March 1978. The cover type and habitat type in which these species were observed are given in Table II-35.

The Montana Legislature has classified many of the species in this Order (Carnivora) as game animals, furbearers or predators for management purposes. Those species which are not so designated are simply referred to as unclassified. Furbearers include those species which have a valuable hide and are protected by law. On occasion pelts of predators and unclassified animals have had higher fur value than furbearers (Mitchell, et. al. 1971).

Two individuals who have trapped in the Lake Creek area were contacted to obtain an historical insight into the abundance and distribution of various species on the study area. In addition to having trapped in the area for eight years, Dennis Cloin is also a fur buyer and Vern Blanchard trapped in this area for over 25 years.

(a) Black Bear

Black bear (*Ursus americanus*) observations and bear sign recorded on the study area is plotted in Figure II-8. Table II-36 shows that 87 percent of the observations occurred in the spring period (April through June) while 68 percent of the bear sign was recorded from July through October. Bear sign included scats (68), tracks (2), diggings (6), marking trees (1), hair (1) and den (1). Bears are usually found in cool moist habitat later in the summer (Tisch, 1961) using limited, shady, moist microsites, they would have been particularly and the summer of 1977 was unusually warm and dry. If bears were difficult to observe during this period. Six of the 15 bears were observed from

Table II-35 Carnivore observations and sign according to cover type and habitat type recorded on the ASARCO copper-silver mine study area from April 1977 through March 1978

COMMON NAME	SCIENTIFIC NAME	WATER	SHORE	SHRUBS	CUTTING UNIT	OPEN AREAS	FOREST	TSUGA-THUJA SERIES	THPL/OPHO	THPL/CLUN	TSHE/CLUN	ABIES GRANDIS SERIES	ABGR/CLUN	ABIES LASIOCARPA SERIES	ABLA/CLUN	ABLA/MEFE	ABLA/CACA	TSME/XETE	ABLA/XETE	ABLA/LUHI	PSEUDOTSUGA MENZIESII SERIES	PSME/PHMA	PSME/AGSP
Black bear	*Ursus americanus*			X	X	X	X			X	X		X	X	X	X	X	X	X	X		X	X
Longtail weasel	*Mustela frenata*			X																			
Marten	*Martes americana*				X		X		X							X							
Mink	*Mustela vison*	X																					
Striped skunk	*Mephitis mephitis*					X	X				X												
Coyote	*Canis latrans*		X	X	X	X	X		X	X	X				X	X			X				
Bobcat	*Lynx rufus*			X	X	X	X				X												
Mountain lion	*Felis concolor*		X		X	X	X		X		X		X	X						X		X	

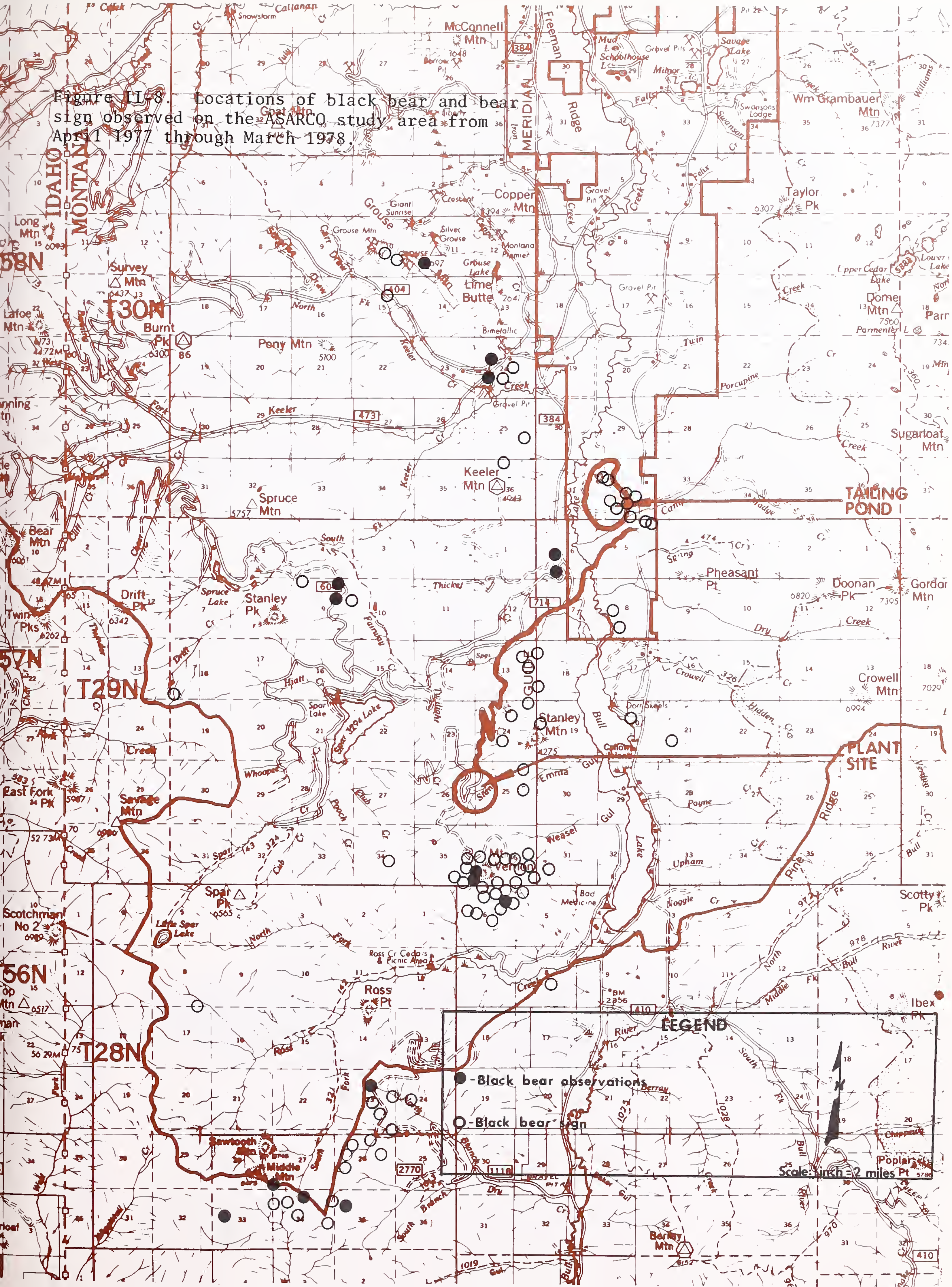
---

[1] Habitat type according to Pfister et. al. (1977). Series names precedes each set of habitat types. See Table II-9 for listing of all habitat types.

[2] Open areas include man-made and natural openings.

[3] Observation or sign recorded by Series if specific habitat type was not determined.

Figure II-8. Locations of black bear and bear sign observed on the ASARCO study area from April 1977 through March 1978.



the air. In 73 percent of the observations, the bears were above 1220 m (4000 ft). The paucity of April information in Table II-36 is likely a reflection of mild spring weather and the fact that this investigation did not begin until April 1977. Greer and Craig (1971) indicate that bears emerge from dens and seek emerging vegetation at low elevations, often along road sides which have been seeded for erosion control. Data collection during this investigation terminated March 15, 1978, before the time of emergence from dens.

Eight bears were observed in the subalpine fir series, six in the cedar-hemlock series and one was seen in the Douglas-fir series (Table II-36). The majority of mining activities are proposed for the TSHE/CLUN habitat type. This habitat type would likely receive substantial spring use by bears seeking early green-up because of its wide distribution at low elevations on the study area.

Since bear sign was not necessarily recent, Table II-36 may not represent the month in which the sign was made. Bear sign appeared to be evenly distributed by elevation and was most commonly observed in the subalpine fir (12 instances) and Douglas-fir series (five instances). Although these figures partially reflect the amount of time the author spent in a series and the extent of a series on the study area, it should be noted that grand fir habitat types are not widely distributed over the study area nor did the author spend a disproportionate amount of time in this series, suggesting that bears may be selecting this habitat type for at least some of their needs. All 11 instances of sign recorded in the ABGR/CLUN habitat type were noted on Stanley Mountain.

Information collected by personnel of Olson, Elliott and Associates (1977) (under contract to the Kootenai National Forest) indicated that the study area sustains a high level of grizzly bear (*Ursus arctos*) food items (see Page 223). Since black bears consume the majority of plant, species listed as grizzly bear food items by Mealey (1977), the study area is also considered to have a high level of black bear food items. Grizzly bear food availability in the Mt. Vernon area as assessed by Olson, Elliott and Associates (1977) indicates that the area has a high food habitat quality rating (Mealey, 1977) for a diverse group of habitats. Although food availability is not likely to be limiting for black bears, critical spring range may concentrate bears in vulnerable situations which often occur along road right-of-ways where green-up first occurs.

(b) Weasel Family and Raccoon

Observations or sign of mammals observed on the study area which belong to the Mustelidae (Weasel) family included: marten (*Martes americana*), mink (*Mustela vison*), longtail weasel (*Mustela frenata*) and striped skunk (*Mephitis mephitis*). Hoffman and Pattie (1968) indicate that other species belonging to this family including fisher

Table II-36 Black bear observations and bear sign summarized according to month on the ASARCO copper-silver mine study area from April through October 1977

	April	May	June	July	August	September	October	TOTAL
Observations[1]	1/7.0	9/60.0	3/20.0	-	-	2/13.0	-	15/16.0[2]
Sign[3]	1/1.3[4]	13/16.5	11/13.9	24/30.4	19/24.0	2/2.5	9/11.4	79/84.0[5]
TOTAL	2/2.1[6]	22/23.4	14/14.9	24/25.5	19/20.2	4/4.3	9/9.6	94/100

[1] Number of black bear observed/percent of total observed.

[2] Total number of black bear observed/percent of total observations and sign.

[3] Number of instances of sign/percent of total sign (sign includes scats, tracks, diggings, marking trees and one den).

[4] Total number of instances of sign/percent of total observations and sign.

[5] Total instances of sign/percent of total observations and sign.

[6] Sum of observations and sign/percent of total observations and sign.

(Martes pennanti), river otter (Lutra canadensis), wolverine (Gulo gulo) and badger (Taxidea taxus) also occur in this region of the state. The raccoon (Procyon lotor) although not in this family will be discussed here. Cover type and habitat types in which these mammals were observed is given in Table II-35. Observations of these mammals occurred incidental to other activities.

According to local trappers weasel and skunk are abundant, the marten population is steady and fisher or fisher sign had not been observed on the area. One trapper had caught two river otter in Lake Creek several years ago and had seen otter sign within the last two years along this drainage. Neither trapper had trapped wolverine but both believed they were present and both reported that badger occur along the Bull Lake-Lake Creek flats. The longtail weasel and the striped skunk are classified as predators and the marten, fisher, mink and river otter are classified as furbearers in Montana. The wolverine is not classified but taking is restricted. The badger is a nongame species.

The raccoon is classified as a nongame species and although a raccoon or raccoon sign was not observed by the investigator, trappers indicated that they are present but rare. During the period 1967-1968 for which data were available, Mitchell, et. al. (1971) indicated that 61 percent of the total annual income to Montana trappers was provided through carnivore pelts (beaver and muskrat accounted for the remainder).

(c) Coyote and Fox

Coyote (Canis latrans) observations were collected incidental to other activities. Coyote tracks (47) and scats (6) were noted at all elevations in all terrestrial cover types and in the THPL/OPHO, THPL/CLUN, TSHE/CLUN, ABLA/CLUN, ABLA/MEFE and ABLA/XETE habitat types (Table II-35). The coyote is classified as a predator in Montana.

Red fox (Vulpes fulva) occur only rarely in this portion of the state (H. Burrell, Montana Department of Fish and Game, game warden, pers. com.) and none were observed on the study area. Red fox are a nongame or unclassified species in Montana.

(d) Mountain Lion

Mountain lion (Felis concolor) observations and sign recorded from 1974 through 1977 on the study area are given in Appendix O. Cover types and habitat types in which mountain lions were observed are given in Table II-35. Forty-two of the 67 lion observations and sign were provided by Ed Vance, houndsman and cooperator in the Montana Department of Fish and Game Mountain lion marking program (K. Greer, Coordinator).

Observations include dead, treed or marked lions while sign includes tracks and scats. All marked lions were first treed by trained dogs, tranquilized, then marked with colored, neoprene rope collars each having a colored, numbered pendant. Distribution of observations and sign is shown in Figure II-9. Although 27 mountain lions were observed over the four and a half year period, some individuals were observed on more than one occasion.

Stanley Creek drainage was shared in 1976 by a marked female lion and a young female with kittens. An adult lion and two kittens also used the Stanley Creek drainage in 1977. Female lions sharing a portion of their home range with other female lions was noted in Idaho by Hornocker (1970). In the population stability of mountain lions, an area which is mutually used by adult females would likely be important. In this instance Stanley Creek constituted the mutual grounds. In 1975 and 1976 a total of eight different mountain lions were known to have used the Stanley Creek drainage or its tributaries (Appendix O).

During a study in Idaho (Hornocker, 1970) about 70 percent of the mountain lion's diet consisted of deer and elk (Cervus canadensis), while snowshoe hare comprised 5.5 percent. Mountain goat (Oreamnos americanus), big horn sheep (Ovis canadensis), small mammals and coyote occurred occasionally in 198 mountain lion droppings collected during the Idaho study. During the present survey, mule deer (Odocoileus hemionus), white-tailed deer and elk were observed in the Stanley Creek drainage. The remains of a male white-tailed deer which had been killed by a lion were noted along Lake Creek in January 1978. Snowshoe hare were frequently seen along the Stanley Creek road and mountain goat occur on Mt. Vernon. Beaver colonies along Stanley and Lake Creeks are thought to be frequented by lions (E. Vance and V. Blanchard, pers. com.) as evidenced by the number of lions which are caught in beaver traps. In this area the proportion of these prey species in the lion's diet is not known.

Almost as important as the mountain lion's prey species is the type of terrain in which they occur. mountain lions often use steep, rocky, brushy country to facilitate their hunting techniques. The occurrence of this type of terrain in the study area may make this area an important hunting ground for mountain lion, but its extent or actual utilization is not known.

(e) Bobcat and Lynx

Bobcat observations occurred incidental to other activities. One bobcat or lynx (Lynx canadensis) was observed running across the Copper Creek road. The specific species could not be identified during the brief observation. Eight instances of bobcat sign (tracks) were noted

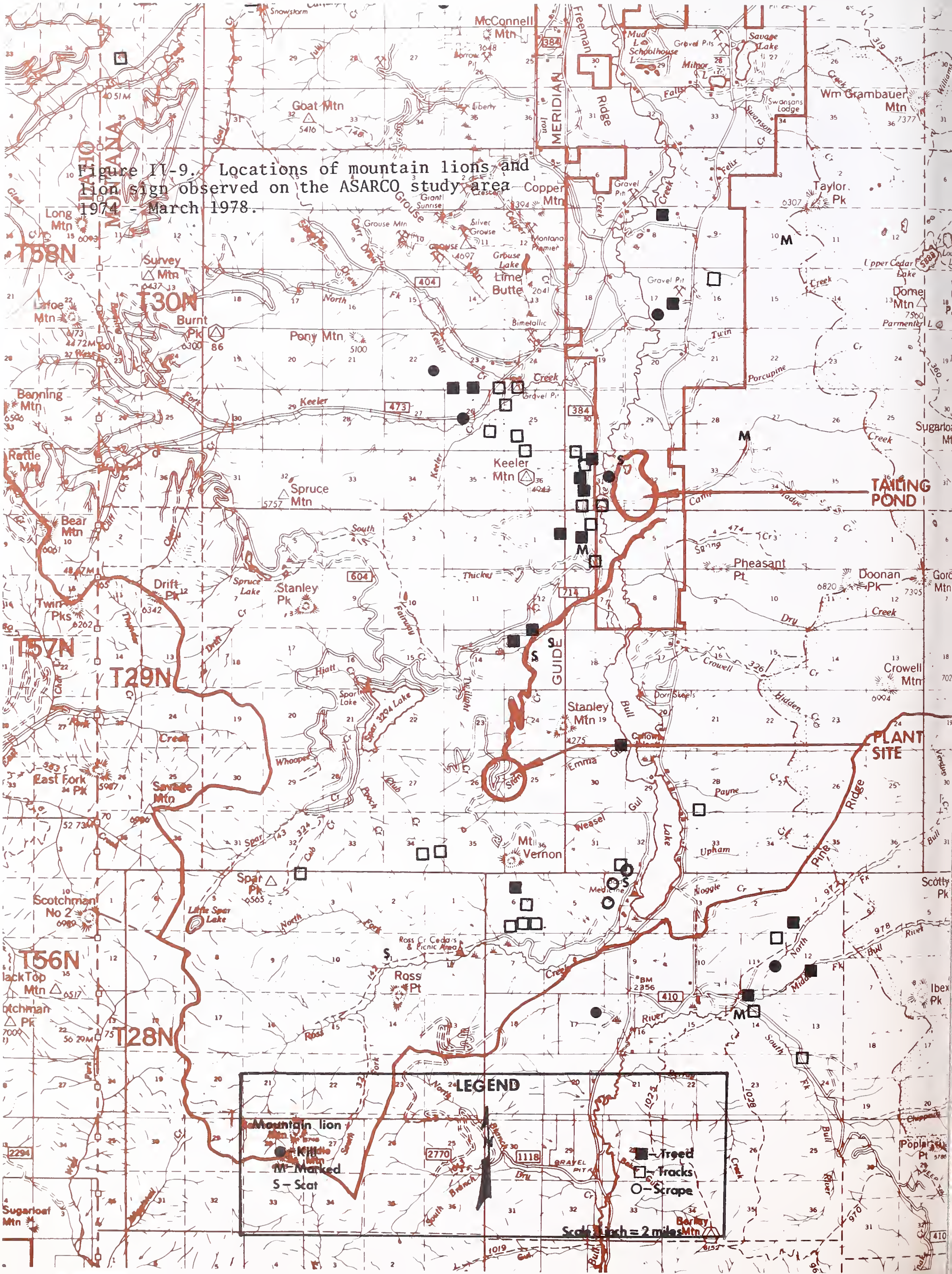


Figure II-9. Locations of mountain lions and lion sign observed on the ASARCO study area 1974 - March 1978.

in the TSHE/CLUN habitat type from December 1977 to March 1978 (Table II-35). Although no confirmed lynx observations were made during this study by the investigator, a local houndsman (E. Vance, pers. com.) has noted lynx tracks in the area during 1977 and Hoffman and Pattie (1968) indicate that lynx do occur in this portion of the state.

(3) Ungulates

Ungulates observed on the ASARCO copper-silver mine study area during the April 1977 through March 1978 report period include: elk, mule deer, white-tailed deer, moose (*Alces alces*), mountain goat and bighorn sheep. Observations and sign of these ungulates were recorded during walking, driving and aerial surveys. Aerial surveys included 16 fixed-wing and three helicopter surveys. Although the major emphasis of the aerial surveys was directed toward locating and classifying mountain goats, the majority of elk and moose observations were also recorded from the air.

Three ungulate browse transects were established on winter range delineated by the Kootenai National Forest (Bull Lake Napolean Planning Unit, in prep. and Keeler Planning Unit Draft 1977). Browse transects on ungulate winter range have been used to document yearly trends in browse utilization (Cole, 1958) and therefore, they were thought to provide an insight into the carrying capacity of the range in relation to existing ungulate populations.

Browse transects were established on the study area and Appendix O presents location information of the Copper Mountain, Keeler Mountain and Ross Creek transects. Aerial and ground reconnaissance during this investigation revealed that the Copper Mountain transect was utilized primarily by deer and moose, the Keeler Mountain transect was utilized by moose and elk and the Ross Creek transect was utilized by deer and elk. However, several researchers (Mackie and Lonner, 1977 and Jorgensen, et. al. 1977) indicate that standard browse transect methods are of limited value in this respect.

In order to establish differential habitat selection by wildlife it would be necessary to determine the availability of each habitat component (percentage of the study area at different elevations, aspects, habitat types etc.). It would also be necessary to systematically and regularly inventory each of the habitat components to determine wildlife utilization. Time constraints and the great diversity of wildlife on the study area did not allow this type of analysis. However, ungulate habitat utilization on a interspecific basis can be established if it is assumed that the likelihood of observing each species was equal. Elk, mule deer, white-tailed deer and moose observation information collected from April 1977 through March 1978 is compared in Tables II-37 through II-42.

Table II-37 Elk, mule deer, white-tailed deer and moose sex and age classification according to month on the ASARCO copper-silver mine study area from April 1977 through March 1978

Species	Classification	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	TOTAL[1]
ELK	Males	2	2	-	5	1	29	9	-	-	-	-	2	50/29.4
	Females	-	-	7	-	8	40	1	-	-	2	-	-	58/34.1
	Unclassified	-	-	-	1	1	12	9	-	-	-	2	-	25/14.7
	Unclassified Adults	5	-	-	1	-	5	-	-	-	-	-	2	13/ 7.7
	Calves	-	-	3	-	5	9	5	-	-	2	-	-	24/14.1
	TOTAL[2]	7/4.1	2/1.2	10/5.9	7/4.1	15/8.8	95/55.9	24/14.1	0/0	0/0	4/2.4	2/1.2	4/2.4	170/100
MULE DEER	Males	-	6	3	1	3	8	1	-	-	-	-	-	22/27.1
	Females	5	19	7	1	9	6	2	-	-	-	-	-	49/60.5
	Unclassified	-	-	1	-	1	2	-	-	-	-	-	1	5/ 6.2
	Fawns	-	4	-	-	1	-	-	-	-	-	-	-	5/ 6.2
	TOTAL[2]	5/6.2	29/35.8	11/13.6	2/2.4	14/17.3	16/19.8	3/3.7	0/0	0/0	0/0	0/0	1/1.2	81/100
WHITE-TAILED DEER	Males	-	-	4	3	1	2	2	-	-	2	-	-	14/14.7
	Females	17	20	2	1	1	2	2	7	-	1	-	-	53/55.8
	Unclassified	2	16	-	-	-	-	-	2	-	2	-	1	23/24.2
	Fawns	-	-	-	-	1	1	2	-	-	1	-	-	5/ 5.3
	TOTAL[2]	19/20.0	36/37.9	6/6.3	4/4.2	3/3.2	5/5.3	6/6.3	9/9.5	0/0	6/6.3	0/0	1/1.0	95/100
MOOSE	Males	-	-	1	-	-	-	-	-	-	2	-	-	3/21.4
	Females	-	-	-	-	-	-	-	-	-	1	-	-	1/ 7.1
	Unclassified Adults	-	1	-	-	-	-	-	-	-	-	5	3	9/64.3
	Calves	-	-	-	-	-	-	-	-	-	-	1	-	1/ 7.1
	TOTAL[2]	-	1/7.1	1/7.1	-	-	-	-	-	-	3/21.4	6/42.9	3/21.4	14/100

[1] Number observed by classification/percent of total observations by species.

[2] Number observed by month/percent of total observations by species.

Table II-38 Elk, mule deer, white-tailed deer and moose observed according to habitat type and season on the ASARCO copper-silver mine study area from April 1977 through March 1978

HABITAT TYPE[1]	ELK					MULE DEER					WHITE-TAILED DEER					MOOSE				
	Spr.	Sum.	Fall	Win.	Tot/%[2]	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%
TSHE-THPL S.[3]	-	-	-	-	0/0	-	-	-	-	0/0	-	-	-	-	0/0	-	-	-	-	0/0
THPL/OPHO	-	-	-	-	0/0	8.9	-	-	-	4/ 5.0	-	8.3	-	-	1/ 1.0	-	-	-	-	0/0
TSHE/CLUN	15.8[4]	0.8	-	100	14/ 8.2	71.1	25.0	-	100	41/50.6	77.0	91.7	86.7	71.4	76/80.0	100	-	-	41.7	7/50.0
THPL/CLUN	-	-	-	-	0/0	-	-	-	-	0/0	3.3	-	-	-	2/ 2.1	-	-	-	-	0/0
ABGR SERIES	-	-	-	-	0/0	-	-	-	-	0/0	-	-	-	-	0/0	-	-	-	-	0/0
ABGR/CLUN	-	-	-	-	0/0	-	-	-	-	0/0	4.9	-	-	-	3/ 3.2	-	-	-	-	0/0
ABLA SERIES	47.4	-	-	-	9/ 5.3	-	12.5	-	-	4/ 5.0	-	-	-	-	0/0	-	-	-	-	0/0
ABLA/CLUN	10.5	-	-	-	2/ 1.2	2.2	-	-	-	1/ 1.2	-	-	-	-	0/0	-	-	-	-	0/0
ABLA/MEFE	-	80.3	24.0	-	118/69.4	11.1	12.5	-	-	9/11.1	1.6	-	-	-	1/ 1.0	-	-	-	-	0/0
ABLA/CACA	-	8.5	-	-	10/ 5.9	-	12.5	-	-	4/ 4.9	-	-	-	-	0/0	-	-	-	-	0/0
ABLA/XETE	-	1.7	-	-	2/ 1.2	2.2	6.3	100	-	6/ 7.4	-	-	-	-	0/0	-	-	-	-	0/0
ABLA/LUHI	-	8.5	-	-	10/ 5.9	4.4	31.2	-	-	12/14.8	-	-	-	-	0/0	-	-	-	-	0/0
PSME SERIES	-	-	-	-	0/0	-	-	-	-	0/0	1.6	-	-	-	1/ 1.0	-	-	-	-	0/0
PSME/PHMA	26.3	-	-	-	5/ 2.9	-	-	-	-	0/0	-	-	13.3	28.6	4/ 4.2	-	-	-	58.3	7/50.0
PSME/LIBO	-	-	-	-	0/0	-	-	-	-	0/0	3.3	-	-	-	2/ 2.1	-	-	-	-	0/0
PSME/CARU	-	-	-	-	0/0	-	-	-	-	0/0	8.2	-	-	-	5/ 5.3	-	-	-	-	0/0
TOTAL[5]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14

[1] See Table II-9 for full scientific and common names of habitat types.

[2] Total number observations in each habitat type/percent of total observations during the year.

[3] Some observations were classified to the series level only.

[4] Percent of observations made during Spring.

[5] Total of observations made during each season.

Table II-39 Elk, mule deer, white-tailed deer and moose observed according to elevation and season on the ASARCO copper-silver mine study area from April 1977 through March 1978

ELEVATION[1/]	ELK					MULE DEER					WHITE-TAILED DEER					MOOSE				
	Spr.	Sum.	Fall	Win.	Tot/%[2/]	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%
610- 760	5.3[3/]	-	-	40.0	5/ 3.0	13.3	-	-	-	6/ 7.4	78.7	75.0	6.7	85.7	64/67.4	50.0	-	-	8.3	2/14.3
761- 910	10.5	-	-	30.0	5/ 3.0	37.8	-	-	-	17/21.0	19.7	-	53.3	14.3	21/22.1	-	-	-	33.3	4/28.6
911-1060	-	-	-	10.0	1/ 0.6	17.8	9.4	-	-	11/13.6	-	16.7	20.0	-	5/ 5.3	-	-	-	58.3	7/50.0
1061-1220	26.3	-	-	20.0	7/ 4.1	6.7	12.5	-	100	8/ 9.9	-	8.3	20.0	-	4/ 4.2	50.0	-	-	-	1/ 7.1
1221-1370	-	-	-	-		6.7	-	-	-	3/ 3.7	-	-	-	-	0/0	-	-	-	-	0/0
1371-1520	21.0	8.5	-	-	14/ 8.2	4.4	6.3	-	-	4/ 4.9	1.6	-	-	-	1/ 1.1	-	-	-	-	0/0
1521-1680	36.8	61.5	25.0	-	85/50.0	11.1	9.4	100	-	11/13.6	-	-	-	-	0/0	-	-	-	-	0/0
1681-1830	-	28.2	75.0	-	51/30.0	2.2	50.0	-	-	17/21.0	-	-	-	-	0/0	-	-	-	-	0/0
1831-1980	-	1.7	-	-	2/ 1.1	-	12.5	-	-	4/ 4.9	-	-	-	-	0/0	-	-	-	-	0/0
TOTAL[4/]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14

[1/] Elevation in meters. Intervals span approximately 150 to 160 m. 610 m = 2000 feet and 1980 m = 6500 feet.

[2/] Total number observations for each elevation class/percent of total observations during the year.

[3/] Percent of observations made during Spring.

[4/] Total of observations made during each season.

Table II-40 Elk, mule deer, white-tailed deer and moose observed according to aspect and season on the ASARCO copper-silver mine study area from April 1977 through March 1978

ASPECT	ELK					MULE DEER					WHITE-TAILED DEER					MOOSE				
	Spr.	Sum.	Fall	Win.	Tot/%[1]	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%
N	10.5[2]	35.9	-	-	44/25.9	13.3	9.4	-	-	9/11.1	-	1	26.7	-	5/ 5.3	-	-	-	-	0/0
NE	-	6.8	75.0	10.0	27/15.9	8.9	34.4	66.7	-	17/21.0	15.2	-	-	-	10/10.5	50	-	-	-	1/ 7.1
E	36.8	4.3	20.8	30.0	20/11.8	11.1	25.0	-	100	14/17.3	22.7	83.3	6.7	14.3	22/23.2	-	-	-	25.0	3/21.4
SE	-	18.8	4.2	20.0	25/14.7	2.0	12.5	-	-	13/16.1	12.1	-	6.7	-	9/ 9.5	-	-	-	-	0/0
S	36.8	4.3	-	-	12/ 7.1	11.1	12.5	33.3	-	10/12.3	-	16.7	13.3	-	3/ 3.2	-	-	-	50.0	6/42.9
SW	-	9.4	-	-	11/ 6.5	-	-	-	-	0/0	3.0	-	-	14.3	3/ 3.2	-	-	-	16.7	2/14.3
W	10.5	17.9	-	-	23/13.5	15.6	3.1	-	-	8/ 9.9	3.0	-	6.7	71.4	8/ 8.4	-	-	-	-	0/0
NW	-	2.6	-	-	3/ 1.8	8.9	-	-	-	4/ 4.9	1.5	-	20.0	-	4/ 4.2	-	-	-	-	0/0
Flat	2.3	-	-	40.0	5/ 2.9	11.1	3.1	-	-	6/ 7.4	42.4	-	20.0	-	31/32.6	50	-	-	8.3	2/14.3
TOTAL[3]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14

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[1] Total number observations in each aspect/percent of total observations during year.

[2] Percent of observations made during Spring.

[3] Total of observations made during each season.

Table II-41 Elk, mule deer, white-tailed deer and moose observed according to topography, configuration and season on the ASARCO copper-silver mine study area from April 1977 through March 1978

TOPOGRAPHY	ELK					MULE DEER					WHITE-TAILED DEER					MOOSE				
	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%
Ridge	-	4.3[1]	-	-	5/ 2.9[2]	2.2	6.3	-	-	4/ 4.9	-	-	-	-	0/0	-	-	-	-	0/0
Upper Slope	10.5[2]	3.4	75.0	-	24/14.1	2.2	28.1	66.7	-	12/14.8	-	-	20.0	-	3/ 3.2	-	-	-	-	0/0
Mid Slope	73.7	35.9	-	60	62/36.5	35.5	53.1	33.3	100	34/42.0	3.3	25.0	33.3	28.6	12/12.6	50.0	-	-	91.7	12/85.7
Lower Slope	5.3	20.5	-	-	25/14.7	33.3	3.1	-	-	16/19.8	31.1	8.3	20.0	57.1	27/28.4	-	-	-	-	0/0
Bench/Flat	10.5	-	12.5	40	9/ 5.3	26.7	-	-	-	12/14.8	65.6	50	20.0	14.3	50/52.6	-	-	-	-	0/0
Creek Bottom	-	35.9	12.5	-	45/26.5	-	9.4	-	-	3/ 3.7	-	16.7	6.7	-	3/ 3.2	50.0	-	-	8.3	2/14.3
TOTAL[3]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14
Configuration																				
Convex	26.3[1]	-	-	-	5/ 2.9[2]	4.4	-	-	-	2/ 2.5	-	-	-	-	0/0	50.0	-	-	-	1/ 7.1
Straight	10.5	13.7	8.3	-	20/11.8	28.9	59.4	33.3	100	34/42.0	57.4	41.7	40.0	28.6	48/50.5	-	-	-	75.0	9/64.3
Concave	10.5	67.5	-	-	81/47.7	-	6.2	-	-	2/ 2.5	-	-	6.7	-	1/ 1.1	-	-	-	8.3	1/ 7.1
Undulating	26.3	18.8	91.7	100	64/37.6	66.7	34.4	66.7	-	43/53.0	42.6	58.3	53.3	71.4	46/48.4	50.0	-	-	16.7	3/21.4
TOTAL[3]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14

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[1] Percent of observation made during Summer.

[2] Total number observations in each topography or configuration class/percent of total observations during year.

[3] Total of observations made during each season.

Table II-42 Elk, mule deer, white-tailed deer and moose observed according to distance from cover, the nearest road and season on the ASARCO copper-silver mine study area from April 1977 through March 1978

DISTANCE TO COVER	ELK					MULE DEER					WHITE-TAILED DEER					MOOSE				
	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%	Spr.	Sum.	Fall	Win.	Tot/%
0- 10 m	57.9[1]	98.3	8.3	60.0	134/78.8[2]	97.8	59.4	33.3	-	64/79.0	60.7	83.3	100	28.6	64/67.4	50.0	-	-	41.7	6/42.9
10- 50 m	36.8	1.7	16.7	-	13/ 7.7	2.2	31.3	67.7	100	14/17.3	31.2	-	-	71.4	24/25.3	-	-	-	25.0	3/21.4
50-100 m	-	-	75.0	-	18/10.6	-	3.1	-	-	1/ 1.2	1.6	-	-	-	1/ 1.0	-	-	-	-	0/0
100-200 m	-	-	-	-	0/0	-	3.1	-	-	1/ 1.2	4.9	16.7	-	-	5/ 5.3	50.0	-	-	16.7	3/21.4
over 200 m	5.3	-	-	40.0	5/ 2.9	-	3.1	-	-	1/ 1.2	1.6	-	-	-	1/ 1.0	-	-	-	16.7	2/14.3
TOTAL[3]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14
DISTANCE FROM ROAD																				
0- 10 m	10.5[1]	-	-	-	2/ 1.2[2]	82.2	25.0	-	-	45/55.6	68.9	100	26.7	85.7	64/67.4	50.0	-	-	-	1/ 7.1
10- 50 m	10.5	-	-	-	2/ 1.2	-	-	-	-	0/0	18.0	-	-	-	11/11.6	-	-	-	-	0/0
50-100 m	-	-	-	-	0/0	-	-	-	-	0/0	3.3	-	-	-	2/ 2.1	50.0	-	-	-	1/ 7.1
100-200 m	-	-	-	40.0	4/ 2.4	-	-	-	-	0/0	4.9	-	6.7	-	4/ 4.2	-	-	-	16.7	2/14.3
over 200 m	79.0	100	100	60.0	162/95.2	17.3	75.0	100	100	36/44.4	4.9	-	66.7	14.3	14/14.7	-	-	-	83.3	10/71.4
TOTAL[3]	19	117	24	10	170	45	32	3	1	81	61	12	15	7	95	2	0	0	12	14

[1] Percent of observations made during Spring.

[2] Total number of observations in each distance to cover or distance to road/percent of total observations during year.

[3] Total of observations made during each season.

(a) Elk

Historically elk were widely distributed throughout Montana but due to settlement of the state herds became increasingly limited to the mountains of western Montana (Rognrud and Janson, 1971). During the report period 170 elk were observed on the ASARCO copper-silver mine study area. Distribution of elk which were observed during the report period are plotted in Figure II-10.

During April and May elk were observed in Stanley Creek and on Keeler Mountain and with two exceptions from June through October, elk were observed in the high elevation basins in and around the head of Ross Creek. From January through March, elk were again observed in the Lake Creek valley on the Camp Creek flood plain, near Bull Lake and on Keeler Mountain. During the summer one elk each was observed on Stanley Mountain and on the Dry Creek flats near the site of the proposed tailings pond. During April elk sign was noted in Stanley Creek and in May elk were observed moving up this drainage. Elk calving areas were not noted on the area although Stearns-Roger (1975) indicate that possible calving areas occur on the west face of Stanley Mountain, along Stanley Creek, along upper Ross Creek or on the south slope of Mt. Vernon.

Sex and age classification of the 170 elk observations and the environmental parameters at the sites at which they were observed are presented in Tables II-37 through II-42. Review of the data concerning each environmental parameter will familiarize the reader with the nature of the terrain in which elk were observed on a seasonal basis.

In order to understand the overall ecology of elk in a particular area, several years of data are necessary to assess herd productivity, status and well-being. In the West Cabinet Mountains and particularly in the area included in the ASARCO copper-silver mine study area limited information was available concerning elk. This investigation was conducted for one year and due to time constraints, the paucity of previous information and the diversity of wildlife in the area, refined life histories and population dynamics cannot be addressed. Information collected on elk during this study is of a baseline nature. Additional information will be necessary in order to assess overall changes in elk ecology of the area due to man-caused environmental changes.

Elk and moose were more observable from the air than either species of deer. The apparent relative abundance of elk as compared to deer was likely a factor of this observability (Table II-37). Over 80 percent of the elk were observed from August through October. Observability of elk at this time was related to rutting behavior, the use of higher elevations which provide a cooler climate and the availability of succulent vegetation (Joslin, 1975). Since the ABLA habitat types are found at higher elevations and have a relatively sparce forest canopy which afforded greater observability over 90 percent of the elk were observed in this series (Table II-38 and II-39).

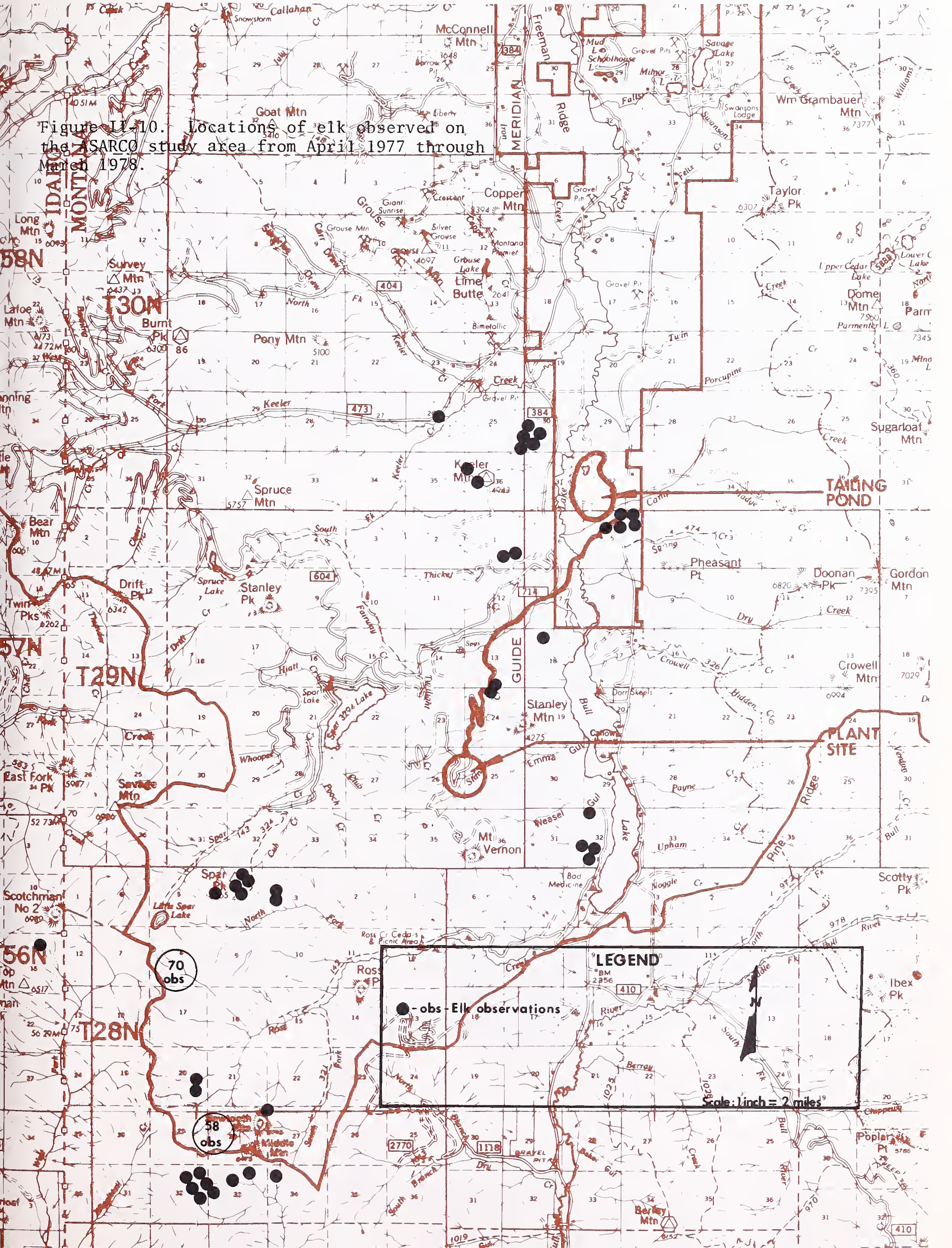


Figure II-10. Locations of elk observed on the ASARCO study area from April 1977 through March 1978.

Elk sign which were recorded during spring and summer were not necessarily representative of those seasons (Joslin, 1978). Sign which were noted during fall and winter were fresh and were representative of areas which elk used during these seasons (Joslin, 1978). Based on the distribution of elk, deer and moose sign, there were no apparent areas used exclusively by elk. Figure II-11 includes federally controlled lands which the Forest has designated as well suited big game winter range. This designation is based on five criteria including: elevation, aspect, habitat type, snow depth and known use areas. Distribution of ungulates on the study area (Figure II-11) differs from well suited big game winter range as designated by the Forest because the occurrence of ungulate sign did not necessarily comply with the criteria established by the Forest, ungulate use areas were delineated without regard for land ownership boundaries and because this study represents one year of information. Stearns-Roger (1975) provides an additional year of information from this area which was more limited but complimentary to this study.

(b) Mule Deer

Mule deer occur throughout Montana and are found in more diverse habitats than any other native ungulate (Egan, 1971). Eighty-one mule deer were observed during the report period and over 1300 instances of deer sign (tracks, pellet groups, beds, etc.) were recorded. Information collected for each mule deer observed from April 1977 through March 1978 and deer sign from April through September 1977 is presented in Joslin (1978). Deer sign collected during October 1977 through March 1978 is summarized in Appendix O and was used to develop the map of ungulate winter distribution (Figure II-11). Distribution of mule deer observed during the report is plotted in Figure II-12.

Sex and age classification of mule deer observed during the report period according to month is given in Table II-37. Summer fawn:doe ratios were not calculated for either species of deer because the secretive behavior of these animals combined with the dense vegetational cover of the area appeared to influence observability of fawns. The calculated mule deer buck:doe ratio was 44.9:100 for the report period as compared to 54:100 in 1974 (Stearns-Roger, 1975). Environmental parameters at each observation site are presented in Tables II-37 through II-42. Review of the data concerning each environmental parameter familiarizes the reader with the nature of the terrain on which mule deer were observed on a seasonal basis.

During April and May mule deer were observed along Keeler Creek, Stanley Creek and Ross Creek (Joslin, 1978). Ten does, four of which were accompanied by fawns of the previous year were noted in Stanley Creek during May and early June, and were thought to be utilizing the

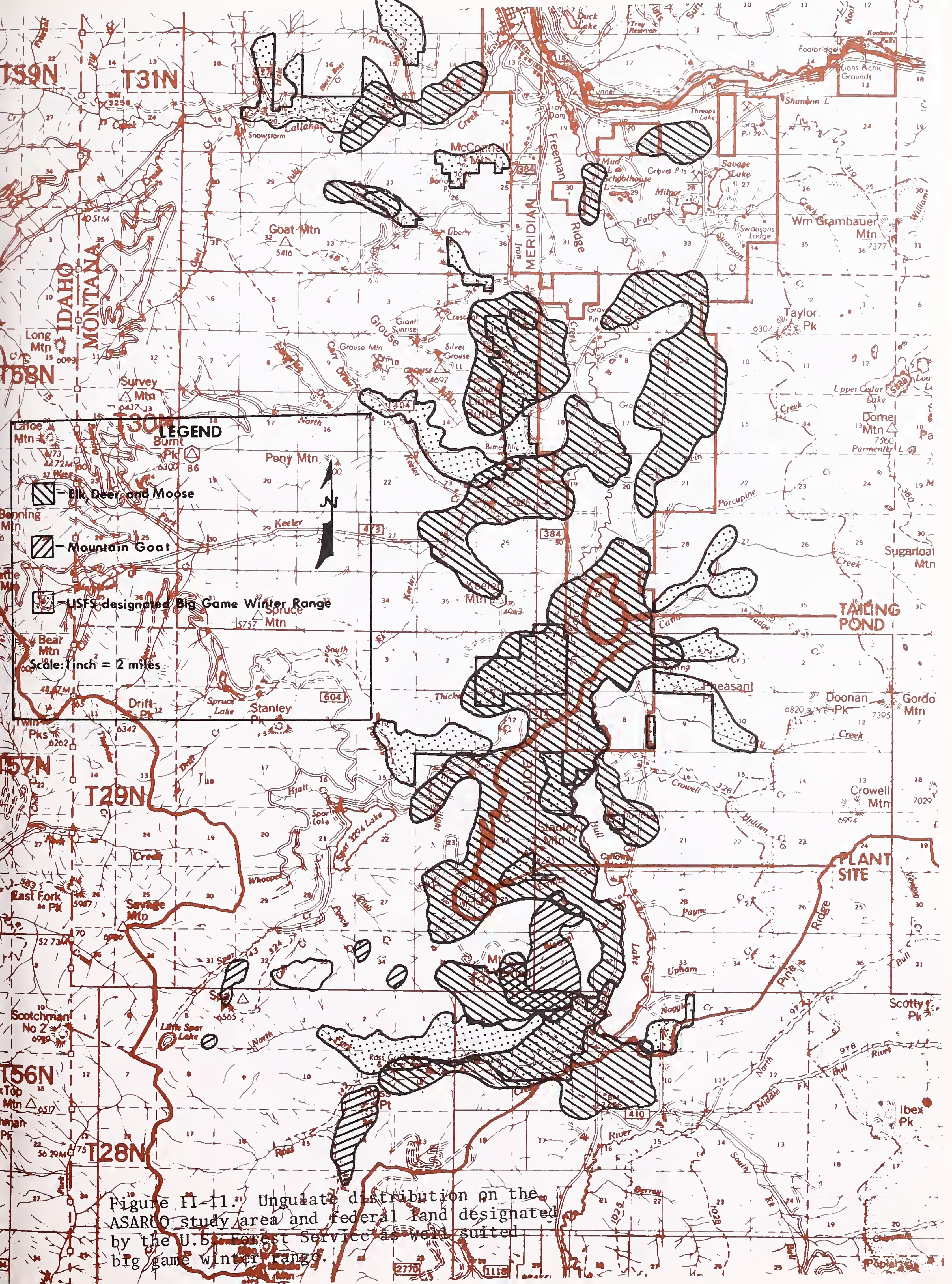


Figure II-11. Ungulate distribution on the ASARCO study area and federal land designated by the U.S. Forest Service as well suited big game winter range.

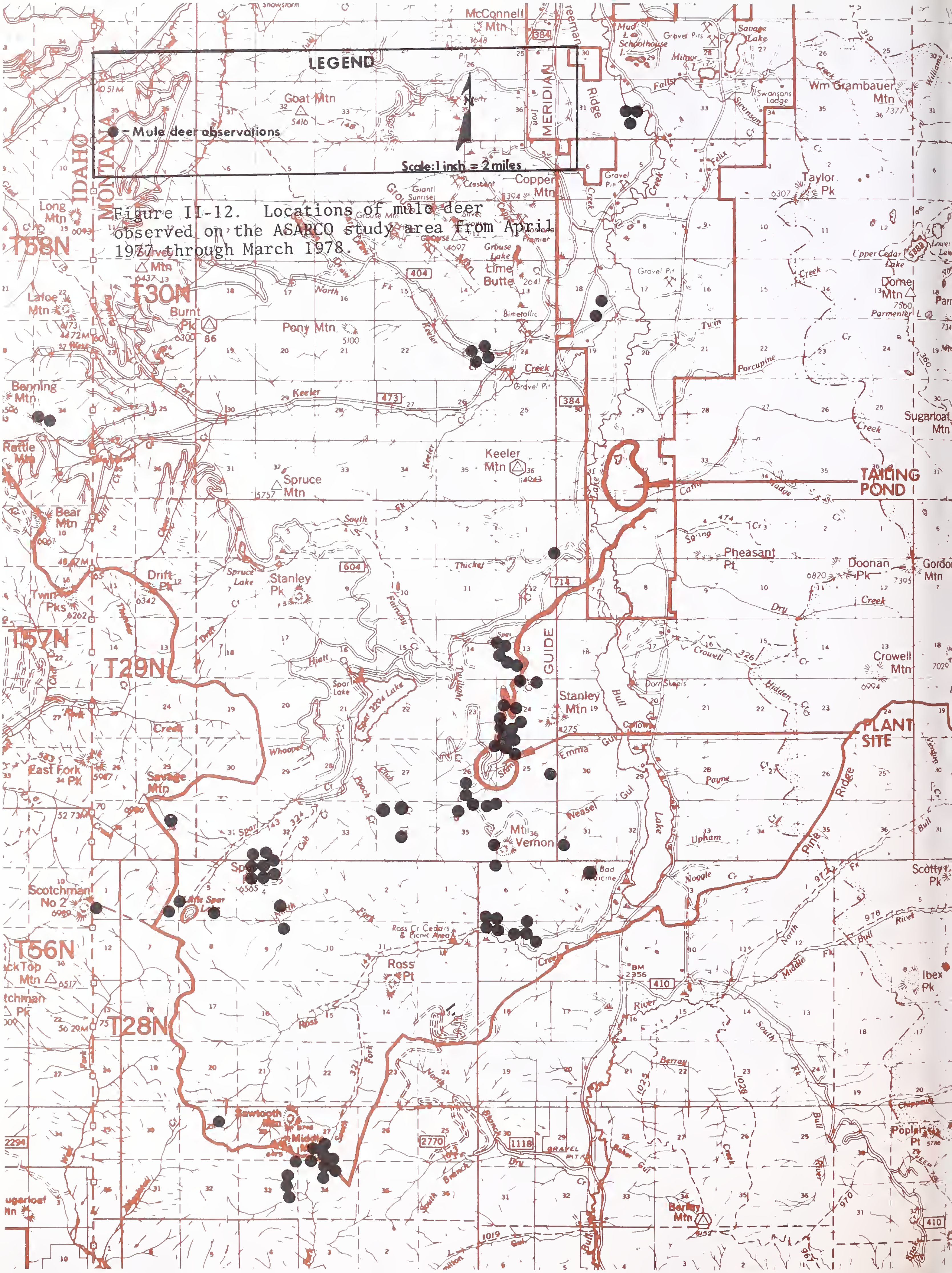


Figure II-12. Locations of mule deer observed on the ASARCO study area from April 1977 through March 1978.

area for fawning although no fawns of the year were observed. The area at and below the proposed lower plant site in particular received use by female mule deer during the fawning period. As June progressed the elevations at which mule deer were observed (Table II-39) increased and Mt. Vernon appeared to be the route used to gain access to the ridge between Mt. Vernon and Spar Peak. Although Stanley Creek and Mt. Vernon were used throughout the summer, over 60 percent of the mule deer observations were made above 1681 m (5500 ft) in the headwaters of Ross Creek and on Spar, Savage and Sawtooth Mountains. The paucity of fall and winter mule deer observations do not allow interpretation of seasonal habitat use. It is probable that mule deer were using the higher elevations (which the investigator did not frequent during the winter months) because mule deer were not observed as commonly as white-tailed deer, elk or moose.

In order to understand the overall ecology of mule deer in a particular area, several years of data are necessary to assess herd productivity, status and well-being. In the West Cabinet Mountains and particularly in the area included in the ASARCO copper-silver mine study area limited information was available concerning mule deer. This investigation was conducted for one year and due to time constraints, the paucity of previous information and the diversity of wildlife in the area, refined life histories and population dynamics cannot be addressed. Information collected on mule deer during this study is of a baseline nature. Additional information will be necessary in order to assess overall changes in mule deer ecology of the area due to man-caused environmental changes.

Deer sign which were recorded during spring and summer were not necessarily representative of those seasons (Joslin, 1978). Sign which were noted during fall and winter were fresh and were representative of areas which deer used during these seasons (Appendix O). Ungulate occurrence (Joslin, 1978) and sign (Appendix O) which were recorded on the study area from October through March 1977-1978 were used to develop Figure II-11. Based on the distribution of deer, elk and moose sign, there were no apparent areas used exclusively by deer.

Information collected by Stearns-Roger (1975) provides an additional year of information from this area which was more limited but complimentary to that found during this study.

(c) White-tailed Deer

White-tailed deer concentrations in Montana have always been greatest in the northwest portion of the state but recently whitetails have increased their range along major river systems east of the Continental Divide (Allen, 1971). Ninety-five whitetails were observed during the report period and over 1300 instances of deer sign (tracks, pellet groups, beds, etc.) were recorded. Information collected for each whitetail observed from April 1977 through March 1978 and deer sign from April through September 1977 is presented in Joslin (1978). Deer sign collected during October 1977 through March 1978 is summarized in Appendix O and was used to develop the map of ungulate winter distribution (Figure II-11). Distribution of white-tailed deer observed during the report period is plotted in Figure .

Sex and age classification of white-tailed deer observed during the report period by month is given in Table II-37. Summer fawn:doe ratios were not calculated for either species of deer because the secretive behavior of these animals combined with the dense vegetational cover of the area appeared to influence observability of fawns. The calculated white-tailed deer buck:doe ratio was 26.4:100 for the report period as compared to 38:100 in 1974 (Stearns-Roger, 1975). Environmental parameters at each observation site are presented in Tables II-37 through II-42. Over 98 percent of the spring whitetail observations were recorded below 910 m (3000 ft) (Table II-39) throughout the Lake Creek valley, primarily along Keeler Mountain, Grouse Mountain, Stanley Mountain and Highway 202. Distribution of white-tailed deer did not appear to change significantly during the spring, summer, fall and winter periods (Figure II-13). Over 83 percent of all whitetail observations were noted within the TSHE-THPL Series (Table II-37) observed use of which was significantly greater than the other ungulate species.

In order to understand the overall ecology of white-tailed deer in a particular area, several years of data are necessary to assess herd productivity, status and well-being. In the West Cabinet Mountains and particularly in the area included in the ASARCO copper-silver mine study area limited information was available concerning white-tailed deer. This investigation was conducted for one year and due to time constraints, the paucity of previous information and the diversity of wildlife in the area, refined life histories and population dynamics cannot be addressed. Information collected on white-tailed deer during this study is of a baseline nature. Additional information will be necessary in order to assess overall changes in white-tailed deer ecology of the area due to man-caused environmental changes.

Deer sign which were recorded during spring and summer were not necessarily representative of those seasons (Joslin, 1978). Sign which were noted during fall and winter were fresh and were representative of areas which deer used during these seasons (Appendix O). Ungulate occurrence (Joslin, 1978) and sign (Appendix O) which were recorded on the study area from October through March 1977-1978 were used to develop Figure II-11. Based on the distribution of deer, elk and moose sign, there were no apparent areas used exclusively by deer although the north slopes of Stanley and Keeler Mountains were used extensively by deer (whitetails were observed) during the late fall and winter. Figure

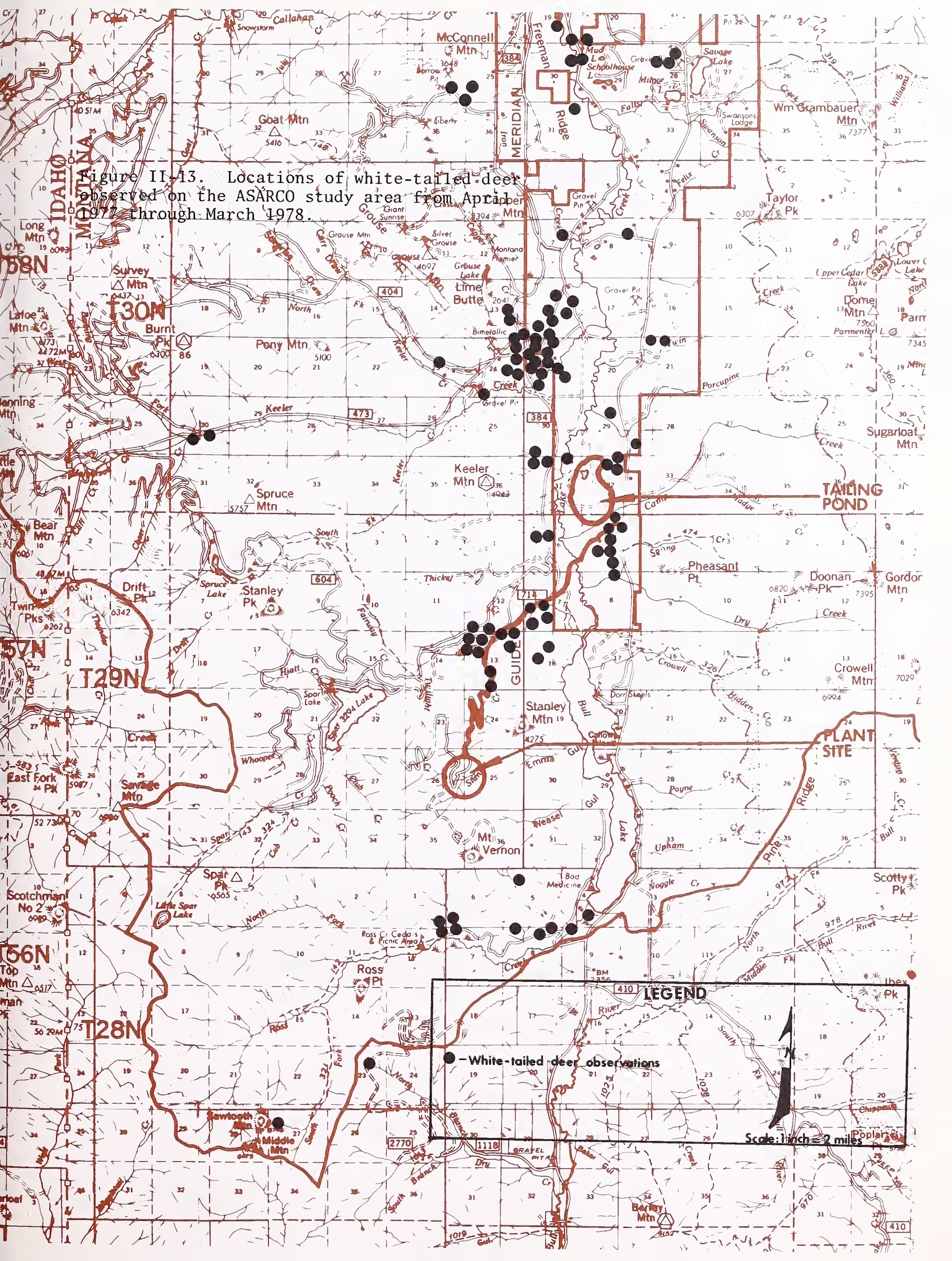


Figure II-13. Locations of white-tailed deer observed on the ASARCO study area from April 1977 through March 1978.

II-11 includes federally controlled lands which the Forest Service has designated as well suited big game winter range. The Stanley Mountain and Keeler Mountain use areas were omitted from the Forest Service winter range map because the criteria were too restrictive.

(d) Moose

Moose distribution in Montana has expanded considerably in the last 25 years, although this may be a reflection of the increasing knowledge concerning moose. Moose are common in the northwest portion of the state (Stevens, 1971). Fourteen moose were observed during the report period and 73 instances of moose sign (tracks and pellet groups) were recorded. Information was collected for each moose observed from April 1977 through March 1978 (Joslin, 1978) and for moose sign (Appendix O) from April through September 1977. Moose sign collected during October 1977 through March 1978 is summarized in Appendix O and was used to develop the map of ungulate winter distribution (Figure II-11). Distribution of moose observed during the report period is plotted in Figure II-14.

Environmental parameters recorded at each moose observation site are given in Tables II-37 through II-42. Spring observations and sign indicate that moose were using the Lake Creek valley although there appeared to be a movement to higher elevations by mid-May (Table II-39). A dead moose was found at the proposed lower plant site on Stanley Creek and another was observed along the east shore of Bull Lake during spring (Figure II-14). Sign was noted at the site of the proposed tailing impoundment near Camp Creek flood, along the north shore of Bull Lake, in lower Stanley Creek and on Mt. Vernon. Little information was collected on moose from June until January but during the winter months 12 of the 14 observations made during this survey were recorded, 58 percent of which were noted on Copper Mountain (Joslin, 1978).

In order to understand the overall ecology of moose in a particular area, several years of data are necessary to assess herd productivity, status and well-being. In the West Cabinet Mountains and particularly in the area included in the ASARCO copper-silver mine study area limited existing information was available concerning moose. This investigation was conducted for one year and due to time constraints, the paucity of previous information and the diversity of wildlife in the area, refined life histories and population dynamics cannot be addressed. Information collected on moose during this study is of a baseline nature. Additional information will be necessary in order to assess overall changes in moose ecology of the area due to man-caused environmental changes.

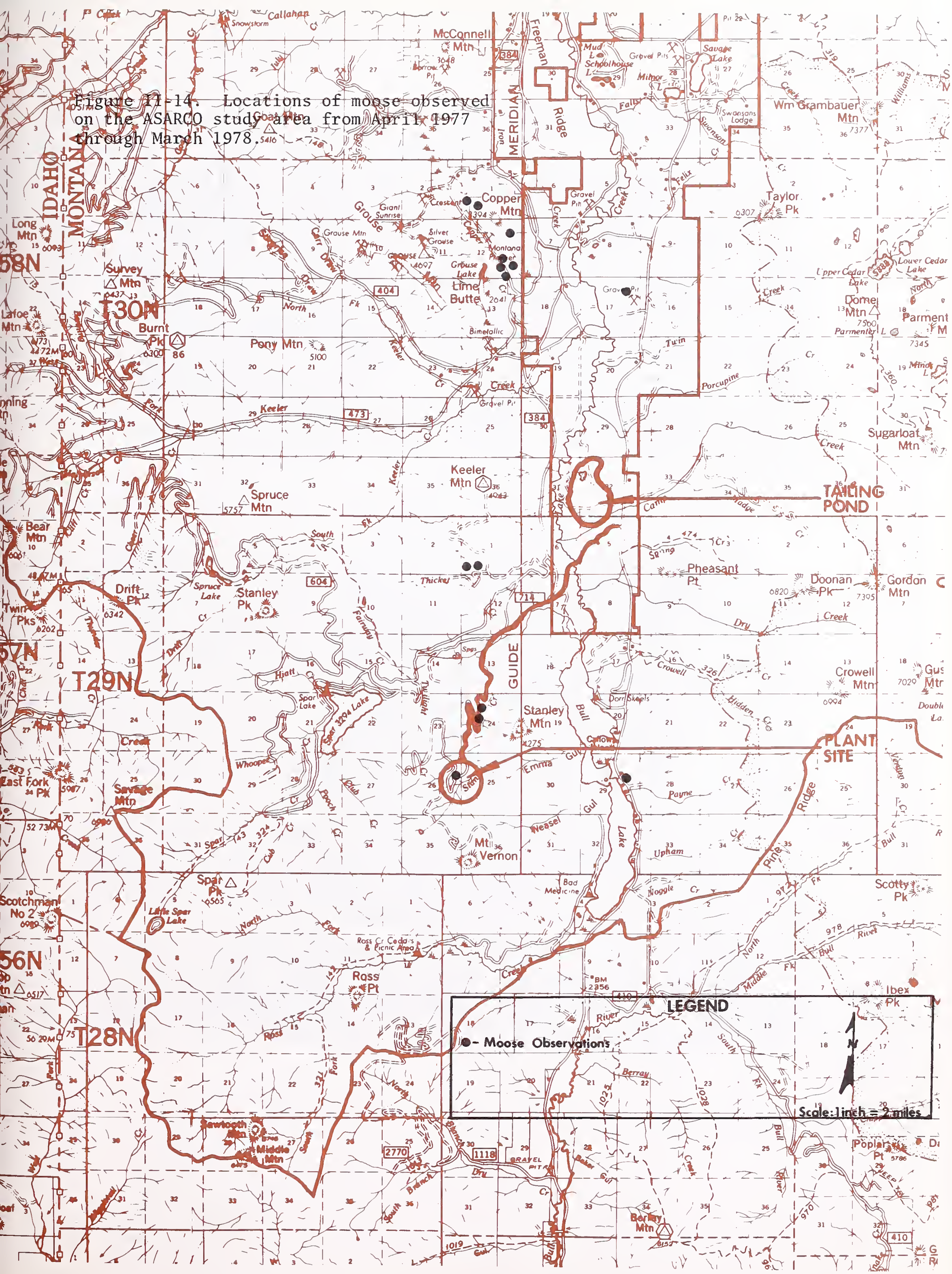


Figure II-14. Locations of moose observed on the ASARCO study area from April 1977 through March 1978.

Moose sign recorded during spring and summer were located in the TSHE-THPL Series in over 83 percent of the instances (Joslin, 1978). Sixty-one instances of sign were noted during the fall and winter, and of those instances 96 percent occurred in this series. Ungulate occurrence (Joslin, 1978) and sign (Appendix O) which were recorded on the study area from October through March 1977-1978 used to develop Figure II-11. Stanley Creek was the only portion of the study area which appeared to be used exclusively by moose during the winter months. Moose ranged out of Stanley Creek north onto the south face of Keeler Mountain, which they appeared to share with elk. FigureII-11 includes federally controlled lands which the Forest Service has designated as well suited big game winter range. A significant omission on the Forest Services' winter range map is the Stanley Creek drainage which is heavily used by moose. This oversight may be due to the criteria system established by the Forest Service which does not consider moderate elevations, north aspects or snow depths that moose are able to contend with. On-the-ground reconnaissance is an important criteria in delineating winter ungulate use areas.

(e) Bighorn Sheep

Historically, bighorn sheep were numerous in Montana, but due to domestic livestock range competition, contraction of disease from domestic sheep and hunting, wildsheep decreased markedly. Evidence indicates that bighorn sheep are not native to the West Cabinet Mountains. In 1969 and in 1975, bighorns were released by the Montana Department of Fish and Game on Berray Mountain, 11 aerial km (7 mi) from Mt. Vernon. Two female bighorns both wearing a color-coded plastic neck band were observed on the south aspect of Mt. Vernon within 500 m of the south adit on three occasions during May 1977. Identification of these collars indicated that these sheep were part of the Berray Mountain transplant. These observations were made on the road at 1460 m (4800 ft) in the ABLA/CLUN habitat type. One of these marked sheep was also observed at the Mt. Vernon location on May 25, 1977. Bighorns sheep have not been observed on the study area since that date.

Local residents and sportsman have reported observing bighorn sheep on Mt. Vernon in the fall of 1975. One of the neck banded sheep observed by the investigator was also observed by E. Vance (local resident, pers. com.) on the North Fork of the Bull River on January 1, 1976 and by J. Brown (Montana Department of Fish and Game, pers. com.) on Ibex Peak on May 29, 1976.

Because of the limited data on bighorn sheep distribution within the study area, the degree which sheep utilize the Mt. Vernon area is not known at this time. Further field investigations will be necessary to determine the status of the bighorns in the Mt. Vernon area and the significance this area has in the habitat requirements of this species.

(f) Mountain Goat

Declines in mountain goat populations throughout their range, from a variety of man-related causes, have sparked concern over the status of this species. During the last 20 years mining, logging, industrial disturbance and increased hunter access have seriously impacted the once thought "secure" mountain goat and it's habitat. Mt. Vernon is an area which currently supports a reproducing mountain goat population. Because of the specific use of Mt. Vernon by mountain goat and because of unique management problems related to mountain goats, special emphasis was directed to the understanding of this herd's status, productivity and well-being.

The mountain goat is the only member of the genus Oreamnos. A member of the tribe Rupricaprinae (Simpson, 1945) the mountain goat is related to the mountain-frequenting antelope of the Old World (Swift, 1940) which include chamois, goral, takin and serow.

The mountain goat is indigenous to the interglacial ranges extending from Oregon, Idaho and Montana to Alaska and the Yukon Territory. Mountain goats inhabit rugged, broken terrain typified by cliffs, ledges, projecting pinnacles and talus slopes. These areas often show well-defined evidence of glaciation (Foss and Rognrud, 1971) and in some cases are highly mineralized. Casebeer et. al., (1950) noted "the steeper the slope the greater the occurrence of mountain goats . . . when they were seen on moderate or gentle slopes, cliffs and ledges were nearby". In Montana, 12 native and four introduced mountain goat herds have been recognized (Casebeer et. al., 1950).

The range of the mountain goat observations on the study area were: Drift Creek to the north, the East Fork of Blue Creek to the south, Scotchman Peak No. 2 to the west and Mt. Vernon to the east (Figure II-15). Mountain goat observations and sign on the study area were not randomly distributed but tended to be clumped in four areas, termed during this study, concentration areas. The general locations of each concentration area, which have been named Mt. Vernon-Spar Peak, Savage Mountain, Sawtooth Mountain and Ross Point, are illustrated in Figure II-16. Some of the mountain goat observations and sign were not incorporated into the concentration areas but they may indicate that travel occurs between the areas. Additional field investigations will be necessary to determine the degree to which mountain goats travel between these areas and whether the boundaries should be altered.

Previous to this study, very limited information was available concerning the mountain goats which inhabit the Mt. Vernon area. Because of this paucity of information and because this study has only been conducted for one year, the data collected to date is of a baseline nature. Although some of this baseline information may not have apparent applicability at this time, it does supply an important starting

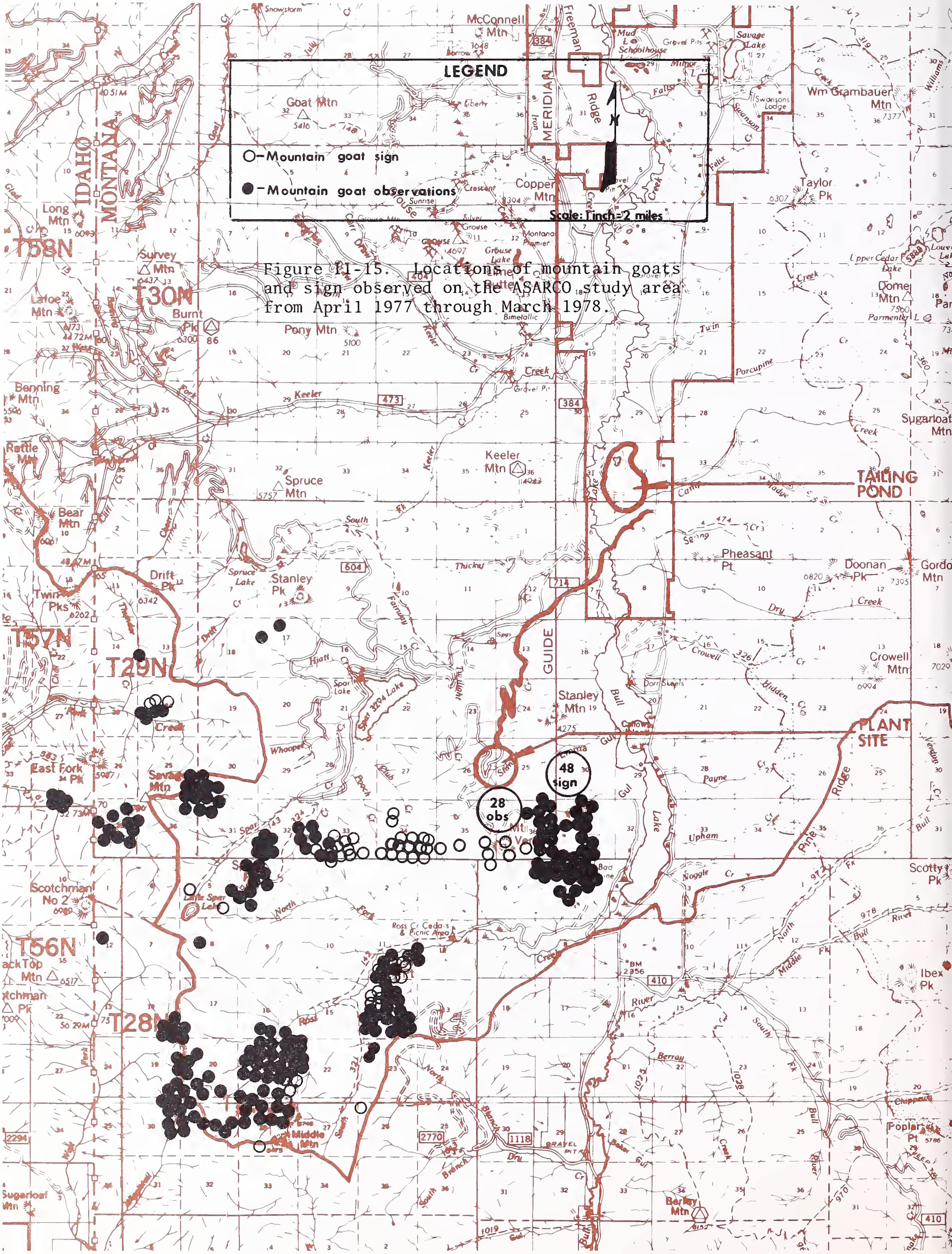


Figure II-15. Locations of mountain goats and sign observed on the ASARCO study area from April 1977 through March 1978.

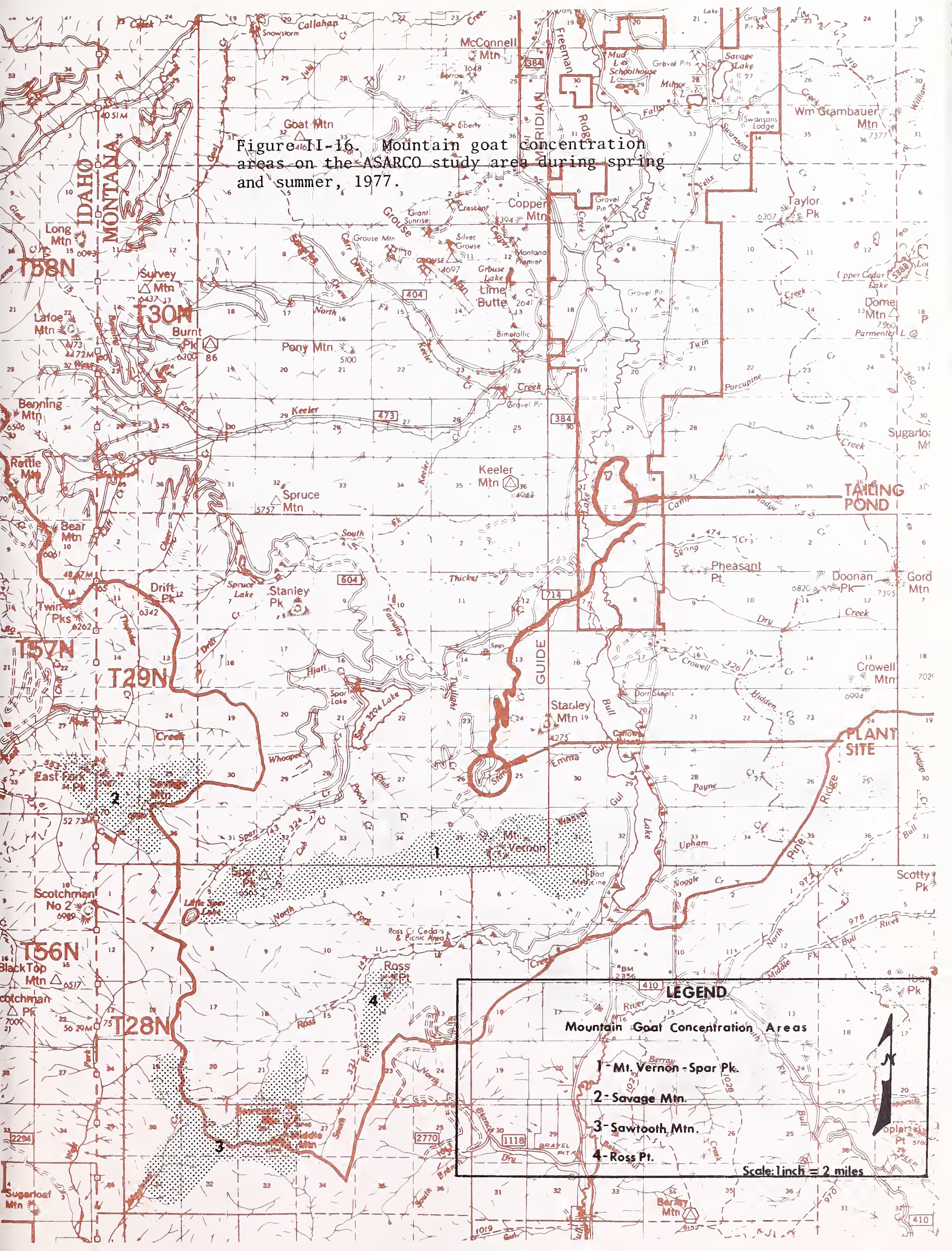


Figure II-16. Mountain goat concentration areas on the ASARCO study area during spring and summer, 1977.

point to which future information can be added in assessing overall changes in mountain goat ecology of the Mt. Vernon area due to man-caused environmental changes. The data does establish that mountain goats are year-long residents of the Mt. Vernon area which is being proposed for mining development.

Mountain goat observations and sign information collected from April 1977 through March 1978 is presented in Joslin (1978). Two-hundred and twenty-six mountain goats were observed during 14 aerial and 16 successful ground trips. Sex and age classification of the mountain goats observed each month is given in Table II-43. Goats were classified as unclassified adults or unclassified goats when some or all of the characteristic features could not be assessed.

Although yearling males show an interest in rut activities, evidence indicates that they are not successful participants. Female goats reach sexual maturity at two and one-half years of age and may produce offspring at three years of age (Lentfer, 1955). Productivity and recruitment rates for most ungulates (elk, deer, etc.) are expressed as the ratio of young and yearlings per 100 females, respectively. Because mountain goats exhibit little sexual dimorphism, it is often difficult to differentiate between males and females in the field, so age ratios are calculated on the basis of adults. Literature concerning mountain goats define productivity as the percentage of kids in the population and express this as the kid:adult ratio (primary age ratio). Recruitment rate is defined as the percentage of kids which survive the winter to make up the yearling cohort (age-class) and are thus "recruited" into the population. The yearling:adult ratio (secondary age ratio) is used to express recruitment rate.

The calculation of primary and secondary age ratios followed the cohort completion technique described by Smith (1976). Using this method the greatest number of goats within each cohort during any one observation trip is utilized and unclassified goats are not used in the computations. On September 27, 16 adults were observed and on July 19 and September 9, five kids were observed. Two yearlings were observed on June 3, August 17, August 18 and September 2. Using these figures the primary and secondary age ratios are 31.2 and 12.5, respectively. Comparatively, a comprehensive calculation using 149 total adults, 38 kids and 13 yearlings results in primary and secondary age ratios of 25.5 and 8.7, respectively.

The knowledge of mountain goat population dynamics is necessary to discuss the current condition or status of the population and the trends which could be expected under natural conditions (without development). Statistics such as kid:adult and yearling:adult ratios suggest productivity and recruitment rates of the herd but simulated population modeling

Table II-43 Mountain goat sex and age classification and average group size according to month on the ASARCO copper-silver mine study area from April 1977 through March 1978

	Average Group Size	Unclassified Adult	Unclassified Goat	Male	Female	Juvenile	Kid	TOTAL
April	8.0(2)[1/]	6	10	-	-	1	-	17
May	3.0(1)	2	-	2	1	-	-	5
June	3.6(8)	12	3	-	9	2	7	33
July	13.0(1)	-	3	1	5	-	5	14
August	5.5(4)	13	-	2	5	2	4	26
September	4.5(12)	42	1	3	5	3	12	66
October	3.8(5)	9	6	-	3	-	3	21
November	4.2(6)	7	2	3	6	4	4	26
December	-	-	-	-	-	-	-	-
January	-	-	-	-	-	-	-	-
February	7.0(1)	4	1	-	3	-	3	11
March	2.5(2)	5	-	1	-	1	-	7
TOTAL	4.6(42)	100	26	12	37	13	38	226

[1/] Average group size (number of groups - singles not included).

provides insight into the limitations of these statistics. According to Caughley (1974) such statistics do not reveal the herd's stability, or lack of. In fact, the kid:adult ratio may be very high as the herd crashes to extinction or very low as the population explodes, depending upon other factors. In order for these ratios to be properly interpreted, repeated censusing is necessary.

Yearly census information should reveal general population trends and an insight into natality, mortality and longevity schedules. Mountain goats have a high mortality rate because they are more disposed to natural hazards such as avalanches, icy cliffs and extreme weather conditions (Kuck 1977, Brandborg 1955 and Casebeer et. al., 1950).

During 14 of 19 aerial trips 173 mountain goats were observed while another 53 goats were observed during 16 ground trips. Several more unsuccessful ground trips were made specifically to locate goats. Average group size is contained in Table II-43. A group consists of a minimum of two animals. Fluctuations in group size may reflect behavioral traits related to the availability of forage. During April, goats congregated on limited late winter and early spring range; in May and June, following snowmelt, animals appeared to disperse onto newly available range and females were seeking solitude for parturition (Brandborg, 1955); in July females with kids and yearlings congregated (Brandborg, 1955) which was the nature of the group of 13 observed on July 19; from August through October the groups dissipated as a possible adaptation to forage dessication. During winter goats were primarily limited to areas having good snow shedding capabilities.

Information in Table II-44 indicates that the disappearance of snow in the spring, vegetation dessication in the fall and snow accumulation in the winter may influence behavioral adaptations. Although not all portions of the study area were censused equally, Table II-44 reflects the number of goats using each aspect by month and provides a measure of goat concentration. The aspect spectrum was divided into eight 45 degree portions.

In April mountain goats appeared to be concentrated on west aspects which receive a high degree of radiant energy resulting in warmer temperatures, early snowmelt and vegetation green-up. The five goats observed during May were using south and east aspects and 33 goats observed in June were using east and north aspects. The spring movements of mountain goats around the aspect spectrum from west to south and east and finally north may reflect a behavioral response of goats to follow vegetation green-up around the mountain. During the warmest months of July and August goats were observed on the cool east and north aspects and as the temperatures cooled in September they dispersed onto all aspects. All of the goats during October and 58 percent of those seen during November were observed on west aspects primarily in the area of Savage Mountain which was not regularly surveyed during the winter because of unfavorable flying conditions. Goats were not observed during December and January.

Table II-44 Percentage of monthly mountain goat observations made on eight aspects on the ASARCO copper-silver mine study area from April 1977 through March 1978

		Aspect							
		N	NE	E	SE	S	SW	W	NW
April	17/37.5[a/]						59	35	6
May	5/37.5			60	20		20		
June	33/62.5	12	36	25	9				18
July	14/24.0	7	93						
August	26/50.0	31		4	4				61
September	66/100.0	9	9	12	11	2	2	27	28
October	21/24.0							52	48
November	26/62.5		27		4	11	47		11
December	0								
January	0								
February	11/50.0	9	64					9	18
March	7/50.0			43	14	29		14	

[a/] Total number of goats observed/percentage of the aspect spectrum on which goats were observed during the month.

All goats observed during February and March occurred on either the Spires of Mt. Vernon or Ross Point. The Spires face north, northeast, east, southeast and south while the cliffs of Ross Point face southwest, west, northwest and north. All aspects except southwest were observed being utilized during the winter months.

Table II-45 reflects mean elevational distribution for mountain goat occurrence. The elevational mode expresses the elevation at which goats were observed most often during each month. According to the mode, goats were observed at the lowest elevations in May, reaching the highest elevations during September. The double mode observed during June may reflect different groups of goats which use different parturition areas. The Mt. Vernon-Spires and Ross Point areas may be the lowest mountain goat habitats within the study area which are used for kidding, but the higher elevations on Sawtooth Mountain also are used at this time.

The October through March data reflect goat movements to lower elevations; the lowest elevational mode was noted during February. The combination of aspect and elevation data presented in Tables II-44 and II-45 supports the suggestion that goats on the study area distributed themselves in response to the first occurrence of highly nutritious spring vegetation. Goats not only follow the green-up around the mountain from west and south to east and north but also from low to high elevations. During the warmer summer months and the advent of vegetation dessication, mountain goats were observed primarily on cool east and north aspects at the highest elevations available. As snow began to accumulate goats moved down and onto the Spires and Ross Point wintering areas where snow shedding abilities and forage availability dictate mountain goat occurrence.

Information concerning food habits of mountain goats has been reported by Hjeljord (1973), Chadwick (1973), Klein (1953), Saunders (1955) and others. This information indicates that food habits vary from area to area and that generalizations regarding food habits cannot be made. From general on-the-ground reconnaissance and the literature cited, the following species may provide an important portion of the winter diet of mountain goats on the study area: huckleberry (Vaccinium globulare), grouse whortleberry (Vaccinium scoparium), beargrass (Xerophyllum tenax), conifer needles and mountain maple (Acer glabrum). Substantial winter use has been made of huckleberry and beargrass on the southern aspect of the Mt. Vernon-Spar Peak ridge and goats have been seen in this area during February and March 1978.

Mountain goat social hierarchy dictates different use of the habitat by goats at different social levels. Adult nannies, particularly those with kids, maintain the dominant position while billies and young nannies comprise the subordinate group (Kuck 1977). Smith (1976) noted that during severe winters "adult females, particularly those with young, exploited snow-free portions of cliffs while subdominants used less

Table II-45 Elevations at which mountain goats were observed on the ASARCO copper-silver mine study area from April 1977 through March 1978

	MEAN[1/]	MODE[2/]
April	1542(5058)[3/]	1585(5200)
May	1542(5060)	1460(4800)
June	1528(5013)	1160(3800)/1700(5600)[4/]
July	1857(6092)	1860(6100)
August	1722(5650)	1950(6400)
September	1656(5433)	2100(6900)
October	1444(4738)	1402(4600)
November	1206(3958)	1219(4000)
December	-	-
January	-	-
February	1288(4227)	1192(3900)
March	1371(4500)	1219(4000)

[1/] Sum of all elevations at which goats were observed divided by number of goats observed.

[2/] Elevation at which goats were most commonly observed.

[3/] Given in meters (feet).

[4/] Equal number of goats observed at both elevations.

optimum habitat. Successful exploitation of optimum habitat, where energy expenditures are minimized, likely promotes survival of females and their offspring". Food supplies ultimately determine the density of goats on preferred cliffs but if severe weather limits food supplies mountain goats disperse themselves in relation to both food and space according to Kuck (1977).

The Spires area of Mt. Vernon and Ross Point meet the criteria for important winter range and both support wintering goats. Mountain goat winter occurrence, based on information gathered during the October through March 1977-1978 period is presented in Figure II-11. Delineation of winter mountain goat occurrence was site specific and therefore, does not reflect comprehensive winter range. Figure II-11 represents federally controlled lands which the Forest Service has designated as well suited big game winter range. Mountain goat winter range is not shown in the Forest Service's big game winter range delineation. Forest Service criteria used in delineating winter range do not provide for the consideration of the type of terrain which mountain goats utilize.

Although mountain goats were observed on Sawtooth Mountain during March 1976 (G. Brown, Mountain Department of Fish and Game, pers. com.) the possible use of the Mt. Vernon and Ross Point areas during the winter by goats which use higher areas during spring and summer cannot be determined without the aid of marked animals. Weather information from the Forest Service indicates that up to 18 m (58 ft) of snow fall accumulates on the West Cabinet Mountains ridges. Although goats have been known to use high elevation winter ranges in other areas (Lentfer 1955), severe winter conditions in this area may dictate migration to lower country having snow shedding abilities such as the Mt. Vernon and Ross Point areas. Mountain goat nannies have a strong instinct to return to the same winter range year after year (Kuck 1977). The Mt. Vernon herd is no exception.

Mountain goat population reduction through logging activities and access development in the late 1950's and early 1960's was exemplified in the Keeler Creek drainage. Personnel from the Kootenai National Forest (J. Dillon, J. Cox, L. Emery, pers. com.) compiled 16 mountain goat observations from this period which occurred over a seven drainage area of upper Keeler Creek. After logging ceased the roads remained open and the abundance of mountain goats in these upper creeks was reduced through public access (J. Dillon, pers. com.). During this study, up to 20 years hence, only one goat has been observed in this area although it is within easy walking distance of the Savage Mountain area. Once extripation occurs, natural reestablishment is evidently a slow process.

4. Endangered or Threatened Species

Certain wildlife species known to occur within the general area proposed to be affected by the mining project, or identified as having the potential to occur in a portion of the area, are threatened with extinction and are provided with protection by the (U. S.) Endangered Species Act of 1973, and the (State) Nongame and Endangered Species Conservation Act of 1973. Those species include the Grizzly bear, perigrine falcon, bald eagle and gray wolf.

a. Peregrine Falcon

The occurrence of the Peregrine falcon in the project area is unconfirmed, although possible sightings have been made recently near Bull Lake. Suitable habitat may be present, although not in the area proposed for direct disturbance by the mining project.

b. Bald Eagle

Bald eagle are known to occur in the general project area, although no nesting sites have been observed or reported. Wildlife biologists indicate that bald eagles probably use the Lake Creek-Bull Lake valley as a travel route from the Kootenai River valley to the Clark Fork valley. They are known to occasionally feed on the waterfowl around Bull Lake, but are not known to winter in the area. The proposed mining development is not in habitat considered critical for bald eagles.

c. Gray Wolf

Although the occurrence of gray wolves in the general project area was reported approximately 20-25 years ago, no information is presently available concerning the possibility of gray wolf occurrence in the general project area. The area proposed to be directly disturbed by the mining project does not appear to be critical habitat for the gray wolf.

d. Grizzly Bear

On April 29, 1977 the Kootenai Forest awarded a contract to Olson-Elliott and Associates to evaluate the quantity and quality of grizzly bear habitat and to document likely grizzly bear use of the proposed ASARCO mine site (intensive study area) and the adjacent vicinity (extensive study area). A detailed description of the methods used to determine grizzly bear habitat quality and use can be obtained from the above contract (Appendix O) and from Mealey (1977).

Grizzly habitat quality is rated high for the vicinity around Mt. Vernon with the proposed mine site located on the outside periphery of the core habitat. Evidence suggests a small population of grizzlies inhabit the West Cabinet Mountains.

(1) Grizzly Bear Habitat Analysis

Data gathered to date indicate the study area has a high food habitat quality rating for a diverse group of habitats. Tentative cover, space and behavioral ratings are all high for the study area.

Grizzly bear habitat has been previously mapped in the Mt. Vernon vicinity by Erickson (1977), Jonkel (1977 and 1976), Weckwerth (1971), Ruediger (1977) and Mealey, et. al. (1977).

Grizzly habitat can be broadly characterized as foraging areas (forested and non-forested), cover and living space. Providing adequate, undisturbed living space is a major problem in managing grizzlies.

The quantity of grizzly bear habitat around the proposed ASARCO mine site has been described in some detail by Erickson (1977) and Ruediger (1977). A detailed survey of grizzly habitat components was prepared by Olson-Elliott and Associates. Mapping of vegetation was prepared by Gerald Moore using the methodology described by Mealey (1977) and Pfister, et. al. (1977). A grizzly bear habitat map was prepared using the habitat type and non-forest component map prepared by Olson-Elliott and Associates (Figure II-17).

The quality of grizzly bear habitat was measured using the method described by Mealey (1977). Each non-forest component, forest habitat type, and major successional stage was measured for food habitat quality, cover habitat quality, space habitat quality and behavior quality.

(a) Study Area Habitat Components

A brief discussion of each habitat component within the study area with their respective code numbers and abbreviations, is contained in Appendix O. Those components which occur within the intensive study area are accompanied by their respective importance values (IV) and food habitat quality rating (FHQR) for spring, summer and fall.

A detailed description of each forest habitat type can be found in "Forest Habitat Types of Montana" (Pfister, et. al. 1977).

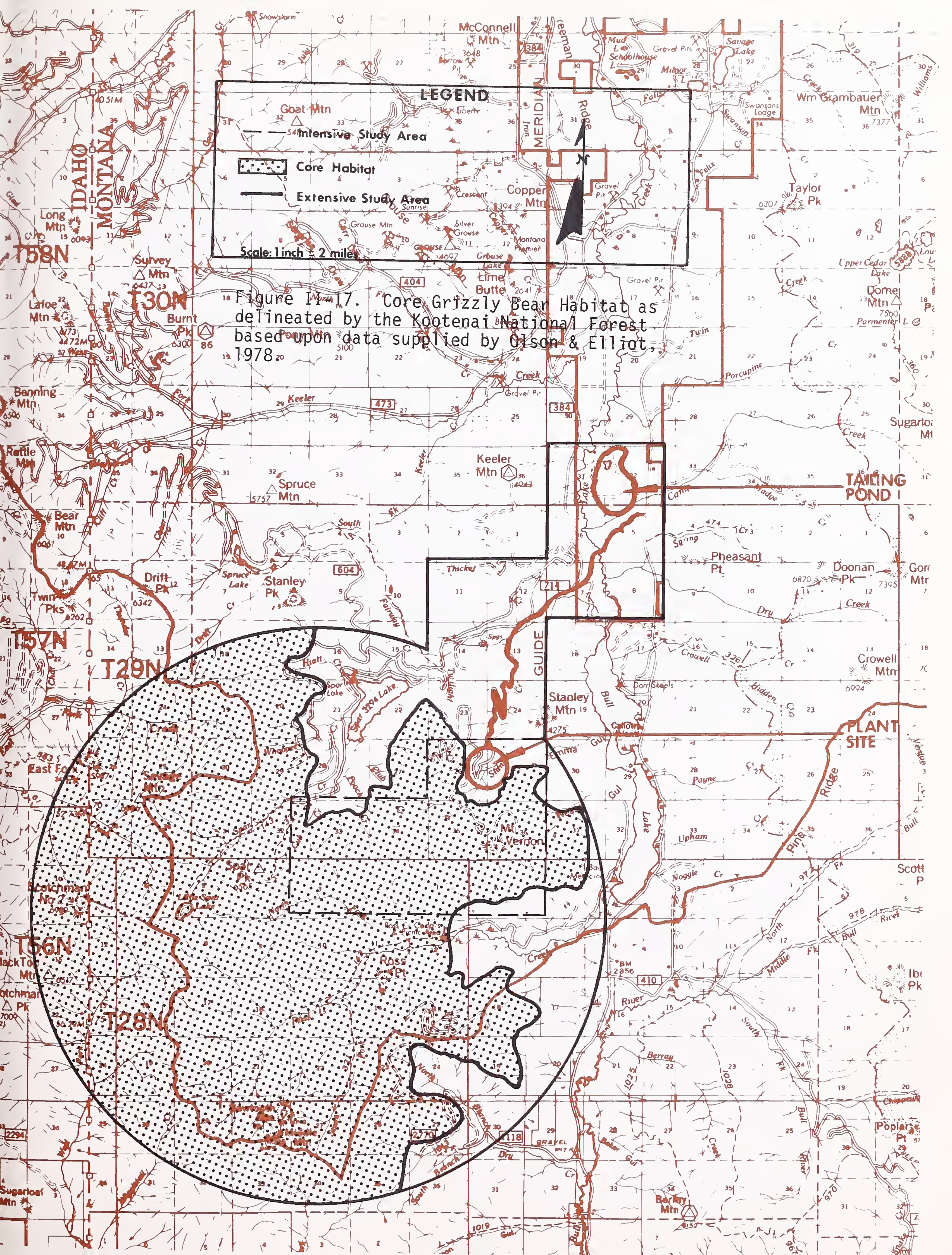


Figure II-17. Core Grizzly Bear Habitat as delineated by the Kootenai National Forest based upon data supplied by Olson & Elliot, 1978.

(b) Animal Food Material

A literal application of Mealey's system was used. The probability of grizzly bear use of animal food material has been assumed in compiling the data. Only indirect evidence of bear use of animal material was noted. A moose carcass judged to have been fed on by black bear was located. The scattered bones of a large whitetail buck were found. The condition of the bones indicated they had been fed upon no later than autumn 1976. No evidence could be found to indicate what animal had fed on the carcass. Both the moose and deer were located on the north slope of the Mt. Vernon-Spar Peak ridge in the TSHE/CLUN H. T. at elevations of 3,900 to 4,200 feet.

From this evidence it was assumed that given the presence of grizzly bear in the study area, they would certainly utilize an animal food source at least when available in the form of carrion. Animal food use was calculated for the alder scrub type based on the presence of game trails through some of the sample plots. These trails appeared to be most frequently used by black bear but deer tracks were seen in the trails and a mule deer doe was seen emerging from a dense alder thicket immediately adjacent to plot MP1-6. An animal food quality rating has been included in all habitat components whether or not animal sign was noted in a given food plot series. All the habitat types in the area appear to be utilized to some extent by big game animals either for food, cover or travel routes. For example, the moose and deer carcasses noted above were found in the TSHE/CLUN H. T. which has virtually no importance as a food source but does provide cover and travel routes. Other types, such as the sidehill parks and shrubfield communities do support rodent populations that are potential grizzly food. The animals indicated on a given data form are those most likely to be encountered in the habitat type in question.

(c) Cover Habitat Quality Rating

Mealey (1977) defines cover as "vegetation and/or topography which hides 90 percent of a grizzly from the view of a person 400 feet away. Cover should have a least diameter of 300 feet or greater". Mealey then assigns a Cover Habitat Quality Rating (CHQR) based on the distance to cover from the plot center. CHQR is high (H) when cover occurs within 600 feet of plot center, medium (M) when between 600 and 1,800 feet, low (L) when between 1,800 and 3,000 feet and zero (0) when cover is absent within 3,000 feet. The CHQR is high (H) for all plots taken in the intensive area. This is primarily due to the dense vegetation cover, either overstory or understory or both, of the area. This vegetation, when coupled with the generally steep topography provides the entire area with a high coverage value for grizzly bear.

(d) Space Habitat Quality Rating

With only partial data at hand, the Space Habitat Quality Rating (SHQR) must be considered high (H) by the parameters outlined by Mealey (1977). The extensive study area is large enough and does contain all habitat components and conditions necessary for grizzly bear survival, in terms of food, cover and remoteness. A high rating with Mealey's system assumes a resident grizzly or population of grizzlies.

(e) Behavior Quality Rating

Assuming a resident grizzly bear or bears, a high behavior rating must be assigned. That is, the bears are not habituated to man; natural foods are used; most bears flee man on encounters and conflict potential is low.

(2) Grizzly Bear Use

Several reports of grizzly bear use of the West Cabinet Mountains have collected in the last 20 years (Kootenai National Forest Records; ERickson 1977). Much of the 1977 field season was spent reviewing the Ross Creek vicinity for grizzly sign. The only conclusive evidence found by Olson-Elliott and Associates was a den believed to be excavated by a grizzly in the Middle Fork of Ross Creek.

Other recent grizzly sign collected in the vicinity of Ross Creek includes:

1. September 1977, Tracks and scats, upper East Fork of Blue Creek, Dr. Al Erickson (personal communication)

2. August 1977, Daybed, scats and hair found near a consumed deer carcass in the Middle Fork of Ross Creek (Ruediger and Erickson)

3. September 1976, Scats, clawed trees on the Pelick Ridge Trail near Squaw Peak (Ruediger and Erickson)

4. August 1976, Sighting, Big Spar Lake Road (J. Shelley)

5. July 1976, Tracks and diggings in the Middle Fork of Ross Creek (R. Hvizdak)

6. June 1976, Tracks on Pelick Ridge (D. Morton) and

7. August 1975, Sighting, East Fork of Blue Creek (M. Comola).

From the data collected it is evident a small population of grizzlies inhabit the West Cabinet Mountains.

C. The Social and Economic Environment

1. Introduction

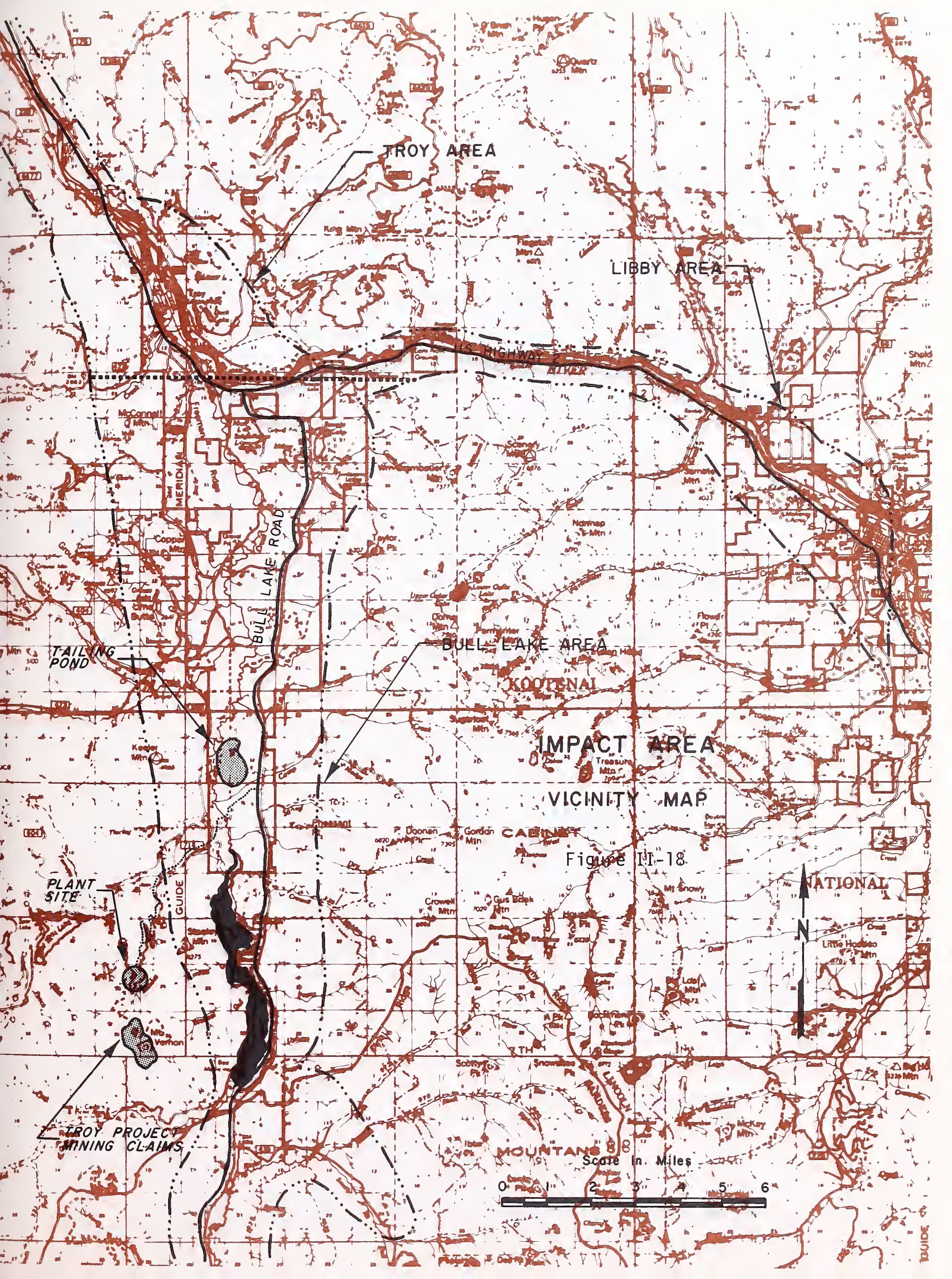
Statistics are generally collected by political or administrative boundaries, with county units usually being the lowest common denominator. Because of this, Lincoln County was selected as the basic area for the social and economic analysis related to the proposed ASARCO Troy Project. However, certain analyses can be conducted for sub-county areas. For Lincoln County these areas are: the Troy area, the Libby area and the Bull Lake area (Figure II-18). Although it is possible to define the Bull Lake area to extend into the adjacent county (Sanders County) it is projected that the impact in that county would be relatively insignificant. Therefore, the Bull Lake area will be principally constrained to Lincoln County.

The existing economic and social environment into which the ASARCO project would be interjected consists of a number of facets. These include the local economy, population, transportation routes, land use, social structure and a wide range of social services. A description of each of these items follows.

2. Local Economy

Historically the economy of Lincoln County has been based to a great extent on wood products manufacturing (logging, sawmill operation, plywood fabrication and byproduct processing). According to the U. S. Bureau of Economic Analysis employment figures from 1967, roughly one-fourth of Lincoln County's total employment has been in the wood products industry. The major employer in this industry is the St. Regis Paper Company in Libby.

Major construction associated with the Libby Dam project became the second largest employment sector through the period 1967-1973. Other major economic sectors include mining (primarily, W. R. Grace Company with its vermiculite operation in Libby) State/Local Government, Federal Government, wholesale-retail trade and railroad transportation. Each of these sectors and others will be examined in greater detail below.


IMPACT AREA

VICINITY MAP

Figure II-18

a. Employment

Total employment in Lincoln County in the recent past (1967-1976) has fluctuated a great deal, ranging from a high of about 7200 persons in 1968 to an estimated low of less than 5700 persons in 1976. Two major factors are responsible for this variation. One is the construction employment related to the Libby Dam, the other is changes in employment in the Wood Products Industry.

Construction on the Libby Dam started in 1966. Employment related to this project reached a peak in 1969 at an estimated level of 1622 employees*. Since that time employment has declined. In 1976 it was estimated at 145 persons.

As mentioned above, fluctuations in employment in the wood products industry have also contributed to instability in total employment for Lincoln County. Employment in this industry peaked in 1968 and has declined more or less since that time.

Employment in other economic sectors has been much smaller than that in the wood products industry and that related to the Libby Dam Project. However, employment levels in these other sectors have changed over the 1967-1976 period. Wholesale-retail trade employment has declined for the most part over the entire period. On the other hand, State/Local Government and Service Sector Employment has increased more or less. Mining employment declined until 1972 and has increased since that time. The number of Federal Government employees was approximately the same for 1967 and 2976 having gone up and down between those two dates. Table II-46 presents more complete information on Lincoln County employment.

b. Income

Total personal income in Lincoln County increased over the period of 1967-1975 due to expanding employment and changes in wage and salary levels. As was the case with employment, the two largest sectors were construction and wood products manufacturing, with the former declining in importance over the period because of its transitory nature. Wood Products and most of the other sectors showed a consistent pattern of increasing earnings. The exceptions were the Wholesale-Retail Trade, Mining and Farm sectors. Earnings in the Trade Sector were up and down from 1967-1972 and showed a consistent upward trend only from 1972-1975. Mining earnings declined from 1968 to 1972 and increased for the remainder of the period. Earnings from farming which comprise a small part of total income for Lincoln County, fluctuated widely with negative incomes in five of the nine years. Complete data on personal income is shown in Table II-47.

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*Annual Average

Table II-46 - Lincoln County Employment by Sector

Sector	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Total Employment	6897	7197	7172	6882	6779	6782	6659	6209	6080	5659
Farm	273	250	229	227	226	222	219	217	206	204
Non-Farm	6618	6947	6943	6655	6553	6560	6440	5992	5874	5455
Federal Government	429	370	419	396	334	370	348	376	436	450
State and Local Government	617	629	591	614	633	636	684	689	679	725
Manufacturing**	1736	1750	1685	1619	1607	1539	1617	1533	1624	1351
Mining	403	392	282	D	D	D	D	D	D	D
Construction	1386	1758	1698	1518	1480	1432	1148	730	409	345
Transportation, Communication, and Public Utilities	233	234	297	300	289	299	294	303	295	303
Wholesale - Retail Trade	760	701	743	680	675	683	701	647	650	650
Finance, Insurance, and Real Estate	62	63	D	63	68	79	86	88	92	85
Services	341	371	422	405	428	460	D	D	D	D
Non-Farm Proprietors	669	673	741	769	789	822	820	822	823	830
Other	6	6	D	D	D	D	6	14	37	16

Source: Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C. - unpublished data.

* Estimate for 1976 derived from unpublished data of the Montana Employment Security Division.
** Manufacturing includes the Wood Products Industry.
D Not shown to avoid disclosure of confidential information. Data are included in totals.

Table II-47 Lincoln County Personal Income by Sector and Category (Thousands of Dollars)

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Wage and Salary Disbursements	40,664	47,298	48,434	47,790	50,825	52,056	52,232	50,280	52,673
Other Labor Income (Primarily Fringe Benefits)	1,724	2,115	2,237	2,310	2,659	2,867	2,871	2,773	3,159
Proprietors Income	3,155	3,100	2,774	3,229	3,211	3,439	4,553	4,643	4,754
Total Labor and Proprietors Income by Place of Work	45,543	52,513	53,445	53,329	56,795	58,362	59,956	57,696	60,586
Farm	-122	-111	-20	159	18	343	301	-303	-489
Nonfarm	45,665	52,624	53,465	53,170	56,777	58,019	59,655	57,999	61,075
Manufacturing	12,200	13,606	13,651	14,025	15,537	15,578	17,911	18,682	22,461
Mining	D	D	D	D	D	D	D	D	D
Construction	15,167	20,043	20,914	D	20,492	20,219	17,052	11,607	6,664
Wholesale - Retail Trade	4,423	4,112	4,181	4,322	4,544	4,419	5,054	5,432	5,906
Finance, Insurance and Real Estate	391	441	425	455	530	577	683	708	787
Transportation, Communication and Public Utilities	2,171	2,376	2,608	2,883	3,053	3,372	3,602	3,924	4,186
Services	D	D	D	2,509	2,636	2,743	D	D	D
Federal Government	3,140	3,145	3,865	4,120	4,092	4,792	4,981	5,689	7,068
State and Local Government	2,978	3,245	2,989	3,139	3,489	3,770	4,112	4,470	5,115
Other Sectors	L	L	64	D	D	D	99	196	245
Less: Personal Contributions for Social Insurance by Place of Work	2,120	2,444	2,744	2,745	3,679	3,601	4,193	4,199	4,349
Residence Adjustment[a]	-2,475	-3,112	-3,357	-3,500	-3,657	-3,674	-3,638	-3,386	-3,519
Total Labor and Proprietors Income by Place of Residence	43,068	49,401	50,088	49,829	53,138	54,688	56,318	54,310	57,067
Plus: Other Income[b]	7,102	8,095	8,572	9,730	11,005	11,960	13,745	16,482	19,200
Total Personal Income by Place of Residence	48,050	55,052	55,916	56,814	60,464	63,047	65,870	66,593	71,918

Source: Bureau of Economic Analysis, U. S. Department of Commerce, Washington, D.C. - unpublished data.

a - Deducts income earned in the county by nonresidents.

b - Includes dividends, interest, rent and transfer payments.

D - Not shown to avoid disclosure of confidential information. Data are included in totals.

L - Less than $50,000. Data are included in totals.

Table II-48 Income Per Capita, Lincoln County and Montana

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Lincoln County	2850	3190	3180	3130	3340	3520	3720	3960	4390
Montana	2750	2910	3180	3500	3580	4070	4780	5080	5430
Difference	100	280	0	-370	-240	-550	-1060	-1020	-1040

Source: Bureau of Economic Analysis, U. S. Department of Commerce, Washington, D. C. - unpublished data.

Income per capita (personal income divided by population) is a commonly used measure of average income for an area. Table II-48 presents per capita income data for Lincoln County and the State of Montana for the period of 1967-1975. As can be seen from Table II-48, average income in Lincoln County has been below the state average since 1969 and exceeded State per capita income only in 1967 and 1968 (it was the same in 1969).

Two factors contributed to Lincoln County being above the state average in 1967 and 1968. First, those two years represented high employment years for the construction of Libby Dam in Lincoln County. Second, 1967 and 1968 were years of low earnings in the Farm sector statewide. Since farm income is an important component of State personal income, these lower than normal earnings significantly decreased state average income for 1967 and 1968.

As mentioned above, per capita income in Lincoln County has lagged behind state average income since 1969. Most significant is the fact that the income gap has widened between 1969 and 1975. This is primarily due to a difference in the growth of personal income statewide as compared with Lincoln County.

Personal income statewide increased by about 85 percent during the period of 1969-1975 while income in Lincoln County went up only 27 percent. Earnings in all sectors statewide increased during the period with the largest absolute income increases occurring in agriculture, Government, wholesale-retail trade and services. Lincoln County's largest income generating sector in 1967 and

1968, Construction, declined by over 300 percent between 1969 and 1975. This was primarily due to the original Libby Dam project winding down (future construction activity related to the Dam is discussed in a subsequent chapter). Increased earnings in other major sectors of the Lincoln County economy such as wood products manufacturing, Government and wholesale-retail trade, were not sufficient to offset the decline in Construction income.

c. City and County Government Expenditures and Revenues

Recorded local government expenditures and revenues are listed in Tables II-49, II-50 and II-51 for Lincoln County, Libby and Troy, respectively. These tables contain the historical tallies for the fiscal years 1973 through 1977.

Expenditures have been broken down into various categories. However, there is no standardization for reporting categories between county, city and town governments. Comparisons by category between the three entities should be made with care.

Lincoln County has shown a 73 percent increase in total expenditures from $1,406,000 to $2,434,000 for fiscal years 1973 to 1977. This growth has been fairly even from year to year with the exception of 1976-1977. During these last two years, there was an unusual jump in expenditures.

County revenues for the same five year period increased by only 12 percent from $2,168,000 to $2,432,000. This lower percentage reflects the ability to better control revenues through mill levies and a surplus accumulation during the years 1973-1975. Property taxes are the major identified source of revenues representing about 22 percent of the total in 1973 and 30 percent in 1977.

The city of Libby experienced a 71 percent increase in total expenditures from $408,100 to $698,800 for the five year period. The year 1976, similar to Lincoln County, represented the maximum expenditure year at $829,700. Several major city funded construction projects associated with the creation of special improvement districts appear to be a prime cause of high 1976 expenditures.

Total revenues for Libby in 1973 were $489,700 and in 1977 they were $719,400. This represents about a 47 percent increase. However, throughout the period there was a declining dependence upon property taxes to generate needed revenue. Property taxes were 53 percent of total revenue in 1973 and 37 percent in 1977. This phenomenon may be due to the availability of grants such as Revenue Sharing funds. For instance, gifts and grants accounted for $170,605 in 1977 and only $71,467 in 1973.

Troy's total expenditures rose from $132,200 in 1973 to $226,400 in 1977, a 71 percent increase. However, a closer look at the

Table II-49 - Lincoln County Government Expenditures and Revenues by Fiscal Year (Thousands of Dollars)

	1973	1974	1975	1976	1977
Expenditures:*					
General Government	381	439	504	656	733
Health Conservation and Sanitation	73	75	109	113	135
Highways, Bridges, Ferries	460	603	767	591	703
Charities and Corrections	229	239	202	236	204
Education	15	17	17	20	20
Miscellaneous	248	302	459	832	639
Total Expenditures	1,406	1,675	2,058	2,448	2,434
Revenues:					
Property Taxes	470	639	672	546	729
Other	1,698	2,219	1,759	1,701	1,703
Total Revenues**	2,168	2,858	2,431	2,247	2,432

Source: Lincoln County Clerk's Annual Report to State Examiner, Fiscal Years 1973-1977.

*Expenditure categories are taken from the annual report and reflect the allocations made by the County Clerk.

**Excludes revenues collected by the County for the governmental units.

Table II-50 - Libby's City Government Expenditures and Revenues by Fiscal Years
(Thousand of Dollars)

	1973	1974	1975	1976	1977
Expenditures:					
Mayor and Council	4.0	7.0	7.0	7.0	7.6
Clerk	8.8	9.8	10.6	11.5	12.6
Treasurer	2.6	3.2	3.1	3.1	3.3
Engineer	4.1	4.5	3.6	3.6	1.1
Attorney	8.7	5.4	6.1	5.0	4.9
Police Court	3.4	4.7	4.3	3.9	4.6
Police Department	91.6	115.4	106.8	89.9	107.5
Fire Department	13.0	11.0	12.4	10.9	11.4
Street Department	75.1	74.9	92.0	89.1	75.1
Sewage Treatment	22.7	27.0	35.8	36.3	40.0
All Other	174.1	359.7	348.2	569.4	442.1
Total Expenditures	408.1	622.6	629.9	829.7	698.8
Revenues:					
Property Taxes	259.6	266.5	271.9	274.8	265.6
Other	230.1	501.2	419.1	482.8	453.8
Total Revenues	489.7	767.7	691.0	757.6	719.4

Source: Libby City Clerk's Annual Financial Statement to State Examiner, Fiscal Years 1973-1977.

Table II-51 - Troy's Town Government Expenditures and Revenues by Fiscal Year (Thousands of Dollars)

	1973	1974	1975	1976	1977
Expenditures:*					
General Government	6.6	5.9	7.1	18.5	72.1
Public Safety	47.4	21.8	42.3	33.6	56.9
Highways and Streets	9.9	5.0	12.7	33.4	42.0
Water	28.2	9.2	10.6	16.4	35.5
Other	40.1	30.4	16.9	16.2	19.9
Total Expenditures	132.2	72.3	89.6	118.1	226.4
Revenues:					
Property Taxes	21.2	21.5	31.5	32.0	35.9
Other	101.6	60.3	77.83	104.6	149.4
Total Revenues	122.8	81.8	109.3	136.6	185.3

Source: Troy's Town Clerk's Annual Financial Statement to State Examiner, Fiscal Years 1973-1977.

*Expenditure categories are taken from the annual report and reflect the allocations made by the Town Clerk.

Table II-52 - Taxable Valuation of Property and Mill Levies for Fiscal Years 1972-1976

	1972	1973	1974	1975	1976
Taxable Valuation:					
Lincoln County	17,219,797	18,673,011	18,758,499	20,063,365	19,731,209
Libby	2,803,213	2,916,723	2,994,751	3,047,278	3,066,530
Troy	431,647	429,429	427,716	465,744	465,744
Mills Levied:					
Lincoln County (County Purpose Only)	32.869	38.018	30.305	30.798	39.061
Libby	66.099	68.149	67.380	69.818	63.691
Troy	50.000	50.000	72.000	75.000	71.000
Total Average Levy in Mills for State, County, and Schools (i.e. all except cities and towns)	127.36	131.82	119.45	124.29	145.46

Source: County, City, and Town Clerk's Annual Financial Statement to State Examiner, Fiscal Years 1973-1977, for Lincoln County, Libby, Troy respectively; Report of the State Department of Revenue for the Periods July 1, 1974 to June 30, 1976 and July 1, 1972 to June 30, 1974, (Helena, Montana); and the State of Montana, Twenty-Fifth Biennial Report, Montana State Board of Equalization, for the Period July 1, 1970 to June 30, 1972 (Helena, Montana).

data indicates that this may not be representative of the real growth. The figures in 1974 through 1975 are substantially lower implying that 1973 may have been an unusually high year. The annual report reflects significant capital outlays in the fire and water Departments in 1973. Thus comparing 1974 to 1977, a more substantial growth of 213 percent results. The category of General Government showed the greatest change over this period increasing twelvefold.

Revenues for Troy have grown to meet the expenditure demands. Revenues were $122,800 in 1973 and $185,300 in 1977, a 51 percent increase. Property taxes have not provided as high a percentage of the total revenues for Troy as for Libby and Lincoln County. They represented a low in 1973 of 17 percent and a high in 1975 of 29 percent. Again Federal grants played an important role providing $78,957 or 43 percent of total revenues in fiscal 1977.

Taxation will be a significant factor in the proposed ASARCO project. Because of this, a closer historical review of the tax base and mill levies for governmental entities operating in Lincoln County follows.

Table II-52 presents taxable valuation and mill levy information for fiscal years 1972 through 1976. Please note in comparing data in this table to revenue data in Tables II-49, II-50 and II-51, that mill levies and taxable valuation lag revenues and expenditures by one fiscal year. For example, the taxable valuation and the mill levies authorized in 1972 apply to revenue generated for operating during fiscal year 1973.

The taxable valuation for Lincoln County, Libby and Troy increased from 1972 to 1976. For Lincoln County, it increased from $17,219,797 in fiscal 1972 to $19,731,209 in fiscal 1976 or an increase of 15 percent. Similarly, Libby increased by 9 percent from $2,803,213 to $3,066,530 and Troy increased by 8 percent from $431,647 to $465,744 during the same period.

Mill levies for all three governmental units fluctuated throughout the five year period, with Lincoln County's being the most erratic. It also should be noted that the mill levies for Libby and Troy are at or above the maximum allowed by law. A ceiling of 65 mills is set for the general, all purpose fund. Exceptions can be and are made under special circumstances (as has been the case for both Troy and Libby). However, there are reasonable limits to these exceptions. Therefore, both cities have approached a ceiling in the amount of property tax revenue that can be collected without an increase in taxable valuation. The latter could be increased either by new construction or by a reassessment of existing property.

Since the County levies taxes for State and school purposes, an average levy based upon the total County taxable valuation is also shown in Table II-52. The levy was 145.46 mills for revenues appropriated in fiscal year 1976. This table also will be used in a later chapter to forecast and compare tax revenue under the scenario of accepting the proposed ASARCO project.

Table II-53 - Lincoln County Population - 1960 - 1976

YEAR	POPULATION*
1960	12,500
1962	13,700
1965	14,800
1966	15,800
1967	16,800
1968	17,300
1969	17,600
1970	18,100
1971	18,100
1972	17,900
1973	17,700
1974	16,800
1975	16,400
1976	16,400**

*Rounded to the nearest 100 persons

**Provisional

Source: U.S. Department of Commerce, Bureau of Census, Current Population Reports, Series P-26 and P-25, for 1960 and 1970-1976 data; U.S. Department of Commerce, Bureau of Economic Analysis, unpublished data for 1962 and 1967-1969. Estimates for 1965 and 1966 were computed by the Research & Information Systems Division of the Montana Department of Community Affairs.

3. Population

Population in Lincoln County increased dramatically between 1960 and 1970 from 12,500 to 18,100 or nearly 50 percent. Since 1970, population declined by 1700 persons to an estimated level of 16,400. Table II-53 presents more complete population data for the period 1960-1976.

The basic reason for the large changes in Lincoln County's population during the 1960-1976 time period was the influx of people related to the Libby Dam construction project. As was mentioned above in the section on employment, construction of Libby Dam started in 1966. Employment peaked in 1969 and declined to an estimated level of 145 workers in 1976. As can be seen from Table II-53, population followed a similar pattern reaching its highest level in 1970 and decreasing through 1976.

Additional population data are available for Troy and Libby, the nearest incorporated communities to the proposed ASARCO mine. Table II-54 presents this data along with the population in the remainder of Lincoln County. It is clear from Table II-54 that Libby experienced the same type of fluctuation in population between 1960 and 1975 that the county as a whole experienced. However, it is also evident that most of the temporary population associated with the Libby Dam project chose to live outside the city limits of Libby.

The age and sex composition of the population of Lincoln County is shown in Table II-55. Age groups with the highest representation are those for children and very young adults (up to 20 years old). The median age for Lincoln County in 1970 was 25.1 years as compared to 27.1 and 28.1 years for Montana and the United States as a whole (Bureau of Census 1970). In addition it should be noted that almost 99 percent of Lincoln County's population in 1970 was categorized racially as White (Bureau of Census 1970).

4. Land Development

Figure II-19 shows the area over which development impact from the proposed project is anticipated. The area has been delineated to show where intensive development impact is expected due to proximity to the mine site and where extensive or scattered peripheral development is anticipated.

Table II-54 - Population of Troy, Libby, and Remainder of Lincoln County

Year	Troy	Libby	Remainder
1960	855	2828	8854
1970	1046*	3286*	13,731
1973	1057	3205	13,439
1975	976	2944	12,452

Source: U.S. Department of Commerce, Bureau of the Census, "Number of Inhabitants - Montana", PC(1)A-28, U.S. Census of Population-1970; and U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 674, May, 1977.

*Part of the change due to annexation.

Table II-55 - Age by Sex for Lincoln County, 1970*

AGE COHORT	TOTAL	Per Cent of Total	MALE	Per Cent of Total	FEMALE	Per Cent of Total
ALL AGES	18063	100	9326	51.6	8737	48.4
under 5 years	1750	9.7	908	5.0	842	4.7
5 to 9 years	2182	12.1	1108	6.1	1074	6.0
10 to 14 years	2212	12.2	115	6.2	1097	6.0
15 to 19 years	1757	9.7	908	5.0	847	4.7
20 to 24 years	1108	6.1	516	2.9	592	3.2
25 to 29 years	1293	7.2	646	3.6	647	3.6
30 to 34 years	1188	6.6	634	3.5	554	3.1
35 to 39 years	1094	6.1	551	3.1	543	3.0
40 to 44 years	1096	6.1	585	3.2	511	2.9
45 to 49 years	1009	5.6	539	3.0	470	2.6
50 to 54 years	998	5.5	538	3.0	460	2.5
55 to 59 years	823	4.6	448	2.5	375	2.1
60 to 64 years	565	3.1	313	1.7	252	1.4
65 to 69 years	383	2.1	205	1.1	178	1.0
70 to 74 years	227	1.3	119	.7	108	.6
75 to 79 years	196	1.1	96	.5	100	.6
80 to 84 years	99	.5	50	.3	49	.3
85 years and over	83	.5	47	.3	36	.2
Median Age	25.1 yr.	N/A	25.8 yr.	N/A	24.3 yr.	N/A

*Percentages may not add because of rounding.

Source: General Population Characteristics - Montana, Bureau of the Census, U.S. Department of Commerce, (August 1971): 72.

a. Existing Land Development

Figure II-20 shows general land use categories that presently exist in the impact area. Residential and commercial developments outside the Libby and Troy urban areas generally follow a strip development pattern. This pattern is due to the topography which limits major buildable areas to those areas lying along streams or major drainages. Due to heavy snowfall in the area, development away from major state or county maintained roads is limited to farmsteads or scattered single residential units.

Figure II-20 shows that strip development is scattered along U. S. Highway 2, north and south of Troy, along the Bull Lake Road south of Highway 2 and extending into Sanders County.

During construction of Libby Dam, a large amount of scattered, strip development occurred along U. S. Highway 2, south of Libby in the area known as the South Libby Flats. These areas are particularly attractive to transient construction workers who live in mobile homes because of low taxes and the fact that the site will only be occupied temporarily. The South Libby Flats area presently has a development moritorium due to groundwater pollution that has contaminated wells in the area.

Linear developments are difficult to serve with centralized sewer and water systems. Costs are high because of the long distances trunks and mains must extend with relatively few hookups.

The area along Bull Lake Road, Lake Creek Road and U. S. Highway 2, north and south of Troy has potential for this type of development.

(1) Troy

The town of Troy was incorporated in 1915. The initial location of the town was determined by the railroad. The original central business district is still in existence near the railroad station, however, in recent years, commercial growth has been along U. S. Highway 2.

Figure II-21 shows existing land uses in the Troy city limits and the immediate surrounding area. It is apparent that the existing centralized water system has done much to control growth in the area.

Within the city limits, the area two or three blocks west of U. S. Highway 2 has space for some additional growth. The area east of the BNRR has a number of dilapidated and vacant structures that could be removed to provide building sites.

Commercial land uses are located in the old central business district which is adjacent to the Burlington Northern Railroad tracks and along U. S. Highway 2.

North and south of the city limits, along U. S. Highway 2, there are some large parcels of privately-owned land that could be developed into commercial or residential uses.

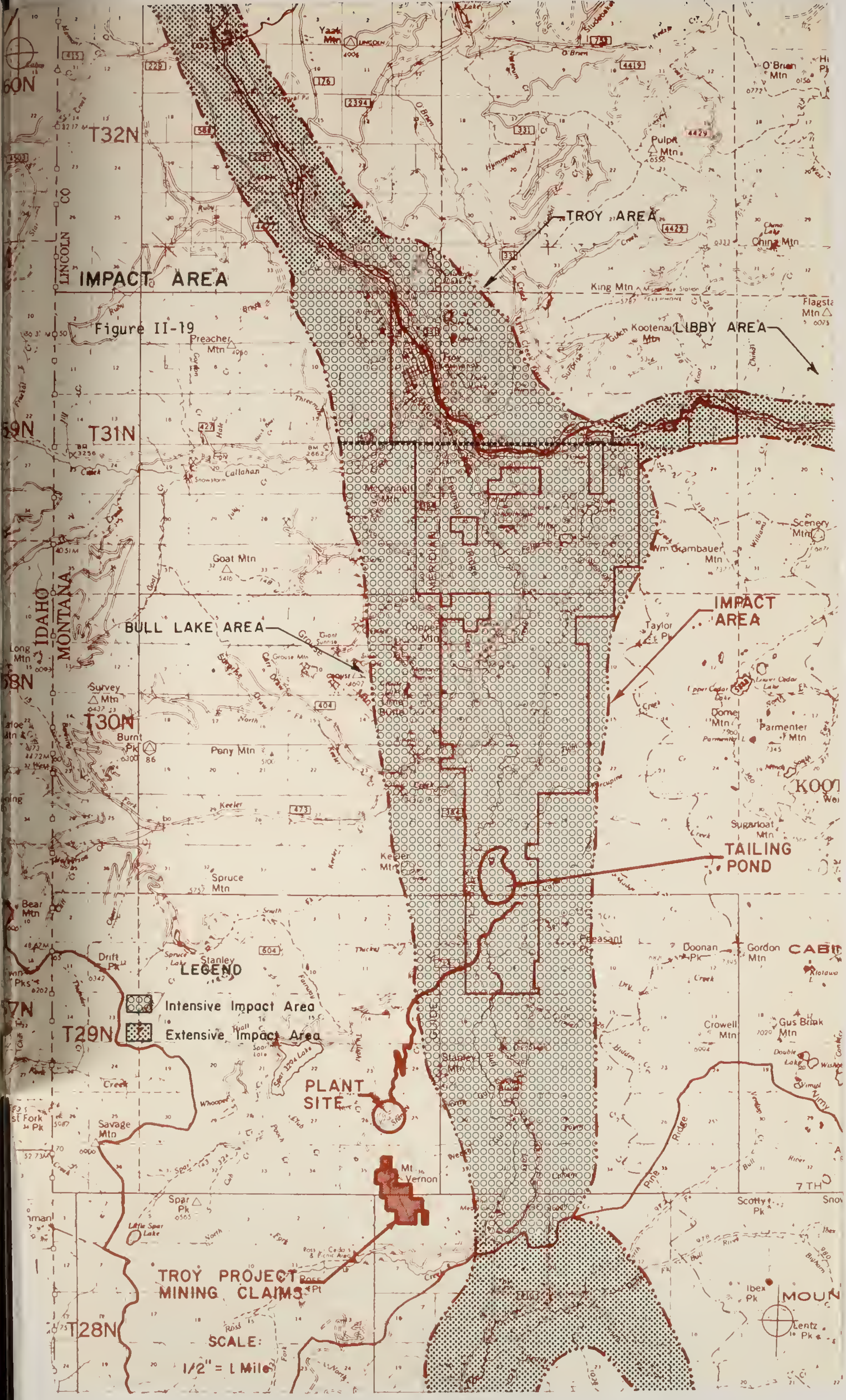


Figure II-19

IMPACT AREA
TROY AREA
LIBBY AREA
BULL LAKE AREA
IMPACT AREA
TAILING POND
PLANT SITE
TROY PROJECT MINING CLAIMS
LEGEND
Intensive Impact Area
Extensive Impact Area
SCALE:
1/2" = 1 Mile
T32N
T31N
T30N
T29N
T28N
LINCOLN CO
IDAHO
MONTANA
Preacher Mtn
Goat Mtn
Pony Mtn
Spruce Mtn
Keeler Mtn
Stanley Mtn
Mt Vernon
Savage Mtn
Spar Pk
Survey Mtn
Burnt Pk
Yaak Mtn
O'Brien Mtn
Pulpit Mtn
China Mtn
King Mtn
Kootenai Mtn
Scenery Mtn
Wm Grambauer Mtn
Taylor Pk
Dome Mtn
Parmenter Mtn
Sugarloaf Mtn
Doonan Pk
Gordon Mtn
Crowell Mtn
Gus Brink Mtn
Scotty Pk
Ibex Pk
Lentz Pk
Callahan
Troy

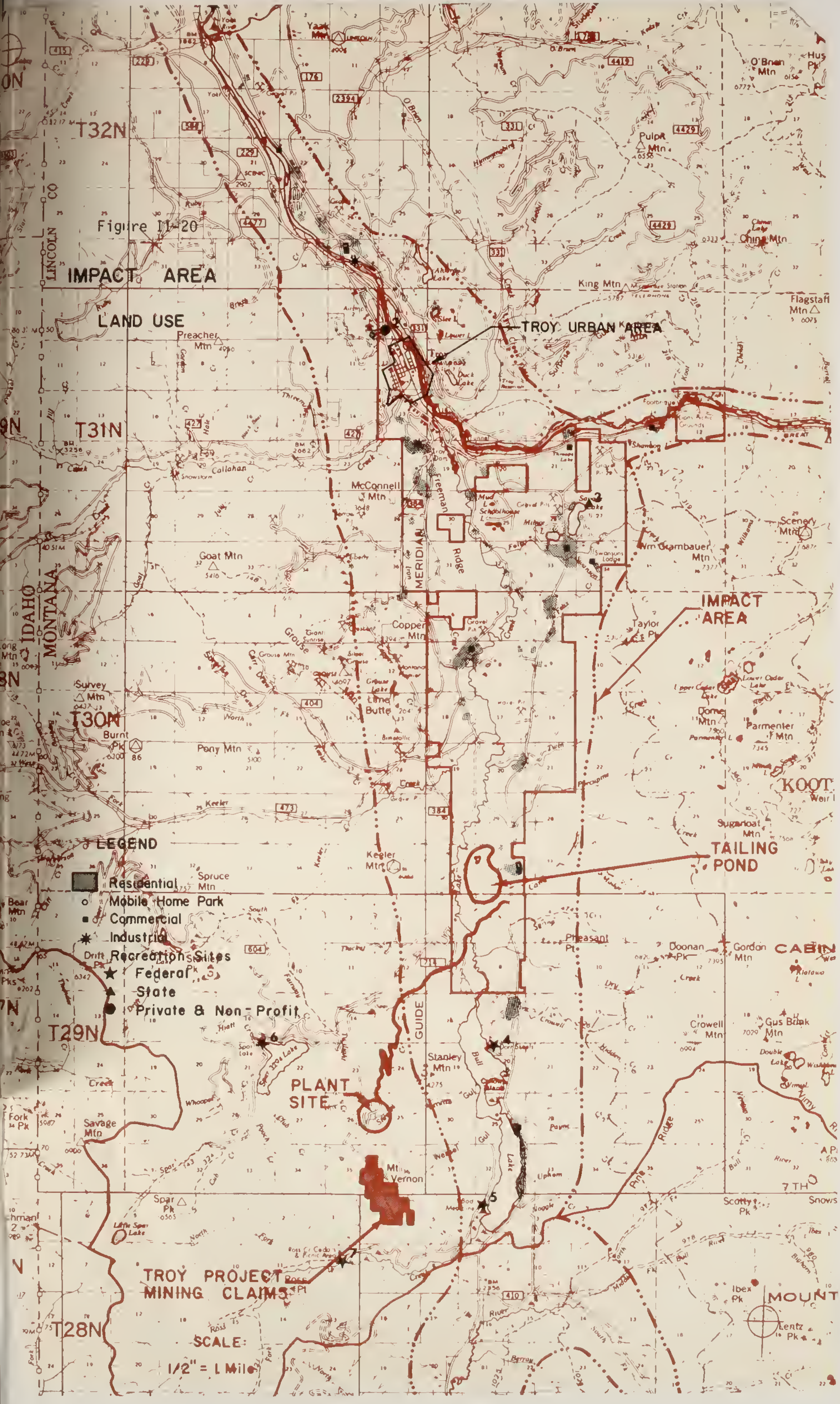
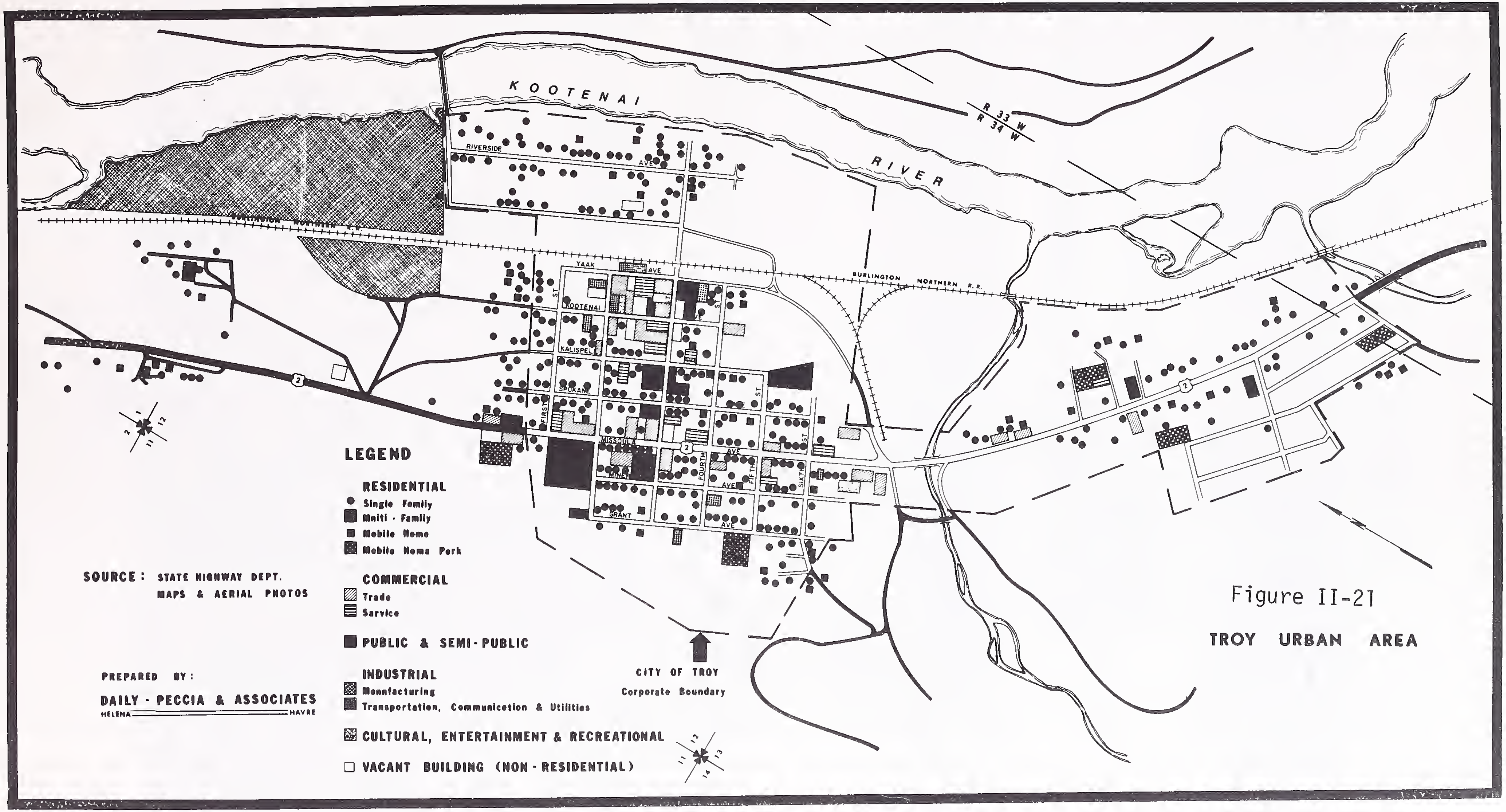


Figure II-20

IMPACT AREA

LAND USE



SOURCE: STATE HIGHWAY DEPT. MAPS & AERIAL PHOTOS

PREPARED BY:
DAILY - PECCIA & ASSOCIATES
HELENA HAVRE

Figure II-21

TROY URBAN AREA

(2) Bull Lake

An inventory of land use in the Bull Lake area was conducted by the Lincoln County Planning Staff in the Fall of 1977.

Within the area shown as the Bull Lake area on Figure II-19 there were determined to be 109 single family homes, 34 mobile homes, four mobile home parks and seven commercial establishments.

Commercial uses in the area consist of the following establishments:

General Store (Presently closed)
Recreational Lodge
Social Club
Bar and Gas Station
Bar, Gas station and Grocery Store
Museum and Taxidermy

Both bars and gas stations are located adjacent to mobile home parks. Although Sanders County is considered to be an extensive impact area with less potential for growth caused by impact of the mine construction and operation, all estimates of development due to mine impact assume that a portion of the development would occur in this area.

(3) Libby

The Town of Libby, like the Town of Troy, developed around the railroad. The Libby central business district has continued to grow in it's location along Mineral Avenue which leads directly to the railroad terminal.

The area around Libby has developed, for the most part, in a strip type pattern. Clustering has been limited to areas that have been subdivided . Individual building lots have developed along U. S. Highway 2 and State HIghway 37 in order to take advantage of regular snow removal which is carried out by the state.

Of the 46,532.9 acres of land in the planning area which extends approximately 4½ miles from the city limits, 1,874.1 acres (4.0 percent) are developed. Most of this development has occurred along the highways to the south, west and north of Libby. Along Highway 2 south of Libby, there are approximately 635 housing units, 291 of which are mobile homes. Well contamination and a high rate of deteriorated housing (17 percent) are examples of the type of problems which strip development has caused. West of Libby, strip development has occurred along U. S. Highway 2. In 1971, there were 64 housing units and 262 mobile homes in the area. Rapid growth has occurred in this area since that time. None of these are served by the city sewer system but most are served by the community water system. Little integration of the various subdivisions or systematic land development to form continuous neighborhoods has occurred. Highway commercial and industrial development is scattered throughout the residential areas along U. S. Highway 2. A few commercial and industrial establishments are located along State Highway 37, the route leading to Libby Dam.

b. Land Capabilities

A number of factors determine the capability of the land in the impact area and the surrounding area, to accommodate development. Some of these factors are: existing land use, land ownership, slope, geology, hydrology, soils and flood plains. The following section evaluates land ownership, slope, flood plains, soils and geology for the impact area.

(1) Land Ownership

Table II-56 contains the percentage of land by major ownership category within Lincoln County.

Table II-56 Major Land Ownerships in Lincoln County (Lincoln County Comprehensive Planning Program 1975)

		Acres	Percent of Total
A.	Governmental Ownership		
	Federal	1,711,687	72 %
	State of Montana	66,330	3 %
		1,778,017	75 %
B.	Corporation Ownerships (Private)		
	St. Regis	198,945	8 %
	Burlington Northern	85,943	4 %
	Champion International	41,885	2 %
	Anaconda Copper and Mining	1,937	1 %
		328,710	14 %
C.	Small Private Ownership	270,873	11 %
	Total	2,377,600	100 %

The Federal and State Governments own 75 percent of the property in Lincoln County. Generally, the lands held by the government or large corporations are not available for development by private individuals. The reasons for this assumption are stated in the Lincoln County Comprehensive Planning Program (1975).

> *After the examination of total land area in terms of ownerships, it is clear this planning program's primary concern should focus on the 270,873 acres held in small private ownerships. The preceding statement is made on the basis of the following considerations.*
>
> *a. The lands held in small private ownerships experience more rapid transitions or changes in use patterns and therefore, the arising conflict or completion of land uses are more evident and numerous . . .*
>
> *. . . The rate of transition of land uses from a typical rural environment of undivided tracts to residential and second home uses has increased in proportion to the expanded population growth during the last 10 years. Since 1965, 51 platted subdivisions have been recorded. These 51 subdivisions have created 1,260 individual tracts from 2,772 acres. Also during this period of time, 3,511 acres have been divided into tracts of less than 10 acres in size by individually recorded land sales.*
>
> *b. The lands that are held in small private ownerships are relatively incapable of expansion. Since the federal land policies have changed, roughly beginning the 20th century, no more public lands are available to the private sector for ownership. The large corporation land holdings are closely related to their particular economics and any future loss of land from this segment affects economic potential. It is evident that the amount of lands available to the disposition of the small private owner is not expanding.*
>
> *On the contrary, the amount held in small private ownership is diminishing. An example of this diminishing land base is also evident in the examination of the dispositions of the homestead entries. Of the original 38,000 acres in homestead entries, the St. Regis Corporation has purchased approximately 4,000 acres and the United States Government and the State of Montana have purchased approximately 2,000 acres . . .*

> *. . . By becoming aware of the needs of this 270,873 acres, we may then be in a position to evaluate land use policies on the other ownership sectors. At that point, we may then take the appropriate steps, such as organized input or public opinion, to see that those land uses are compatible with our needs.*

Table II-57 shows major land ownerships within the intensive impact area (Figure II-22). As shown in Figure II-19, only a limited amount of National Forest land has been included in the impact area since this land will not be available for development.

Table II-57 Major Land Ownerships in Project Intensive Impact Area

Owner	Acres	Percent of Total
St. Regis	18,485	34.9 %
Burlington Northern	1,375	2.6 %
ASARCO, Inc.	66	0.1 %
Mining Claims	148	0.3 %
Other Private Ownerships	11,792	22.2 %
State of Montana	2,714	5.1 %
U. S. Forest Service	14,671	27.7 %
Water Area	1,937	3.6 %
Kennecott Copper Corporation[1]	1,840	3.5 %
Total	53,028	100.0 %

[1] Located adjacent to project impact area (Sanders County).

The land that will be most susceptible to mine impact development is that classified as other private ownership. There will also be a certain amount of land extending south into Sanders County that may have development pressures from the mine impact. This land is assumed to be included within the Bull Lake impact area.

(2) Slope

Within the intensive development impact area, the slope of land available for development will limit the land area available for residential and nonresidential land uses. Figure II-23 shows slopes within that area. Land with slopes ranging from zero to 15 percent are considered to be developable. Slopes of 16 percent and over present severe development problems and are considered to be nondevelopable for this evaluation. Table II-58 shows the land area for each slope category.

Table II-58 Intensive Impact Area Topography

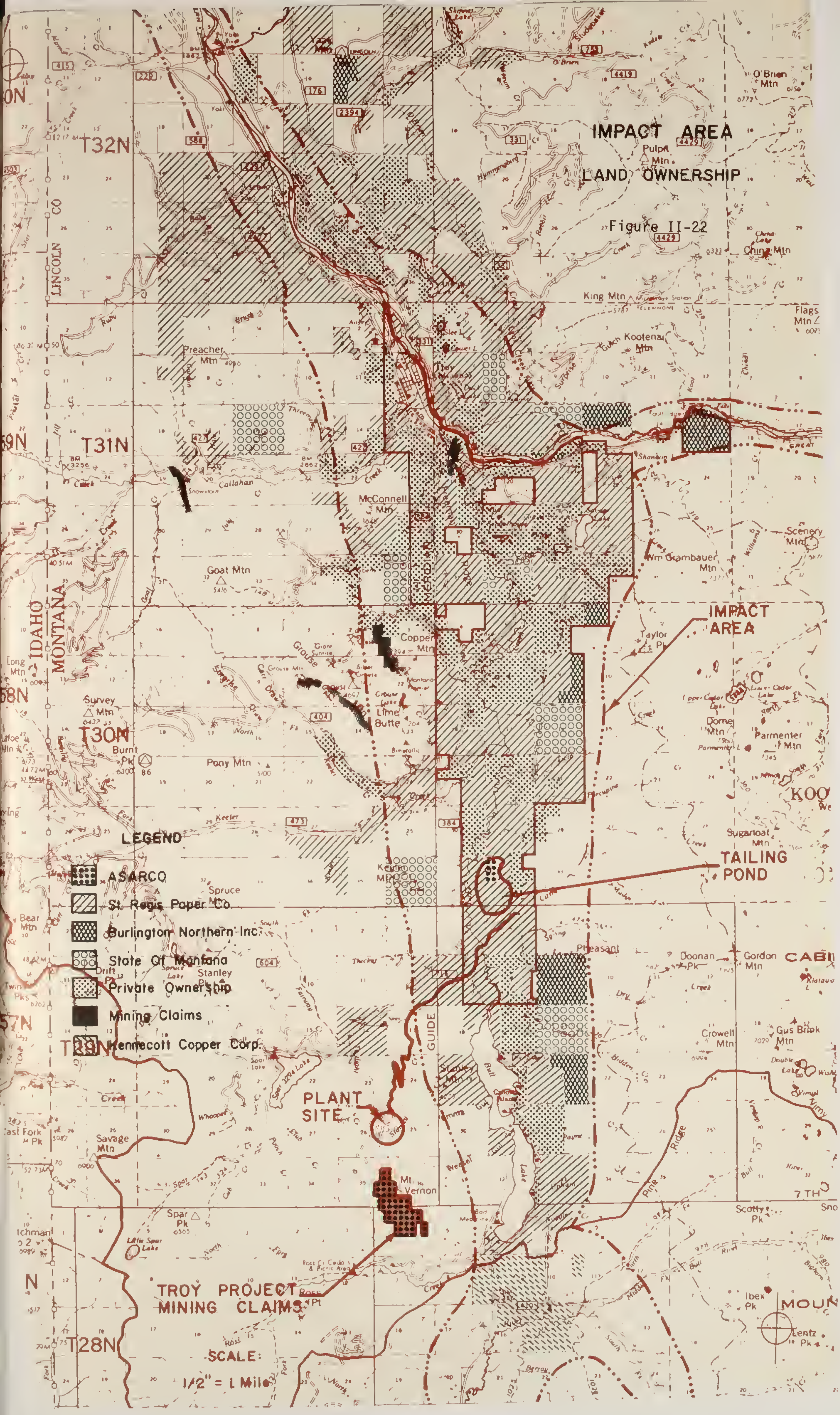
Slope Range	Acres	Percent of Total
Water Area	1,937	3.7 %
Zero to 15 percent	23,401	44.1 %
16 to 25 percent	4,128	7.8 %
Over 25 percent	23,562	44.4 %
Total	53,028	100.0 %

The foregoing table shows that 44 percent of the land along Bull Lake Road between U. S. Highway 2 and Bull Lake would be developable based upon the slope.

(3) Soils

Soils within Lincoln County have been classified by the U. S. Department of Agriculture, Soil Conservation Service. These classifications are very broad, but are sufficient to provide a general analysis of the capability of the soil to provide structural stability for construction of roads or foundations and the percolation characteristics of the soil which determines the feasibility of individual sewage systems.

General soil categories are shown in Figure II-24. The intensive impact area has four general soil categories. These are described as follows:



IMPACT AREA LAND OWNERSHIP

Figure II-22

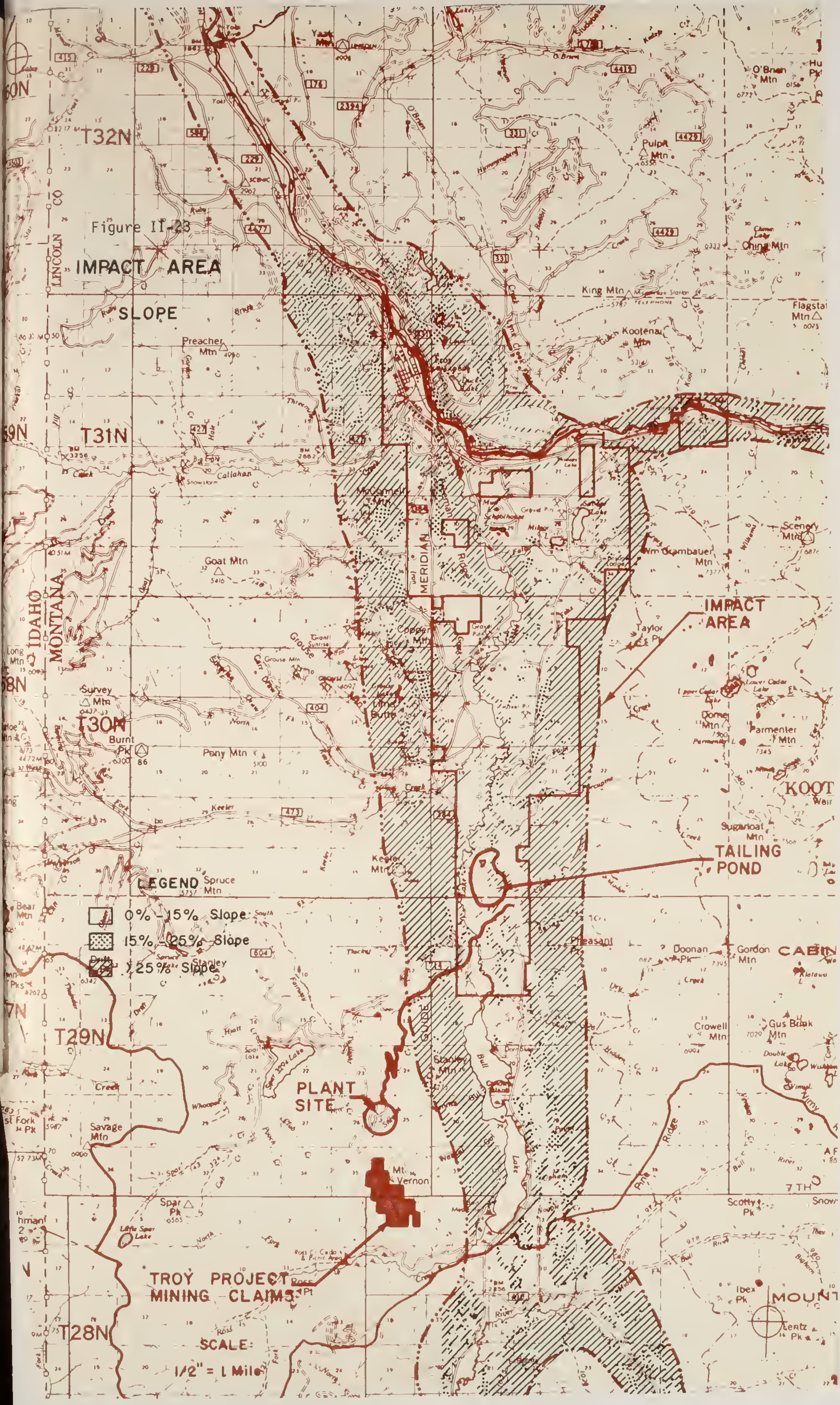


Figure II-23

IMPACT AREA

SLOPE

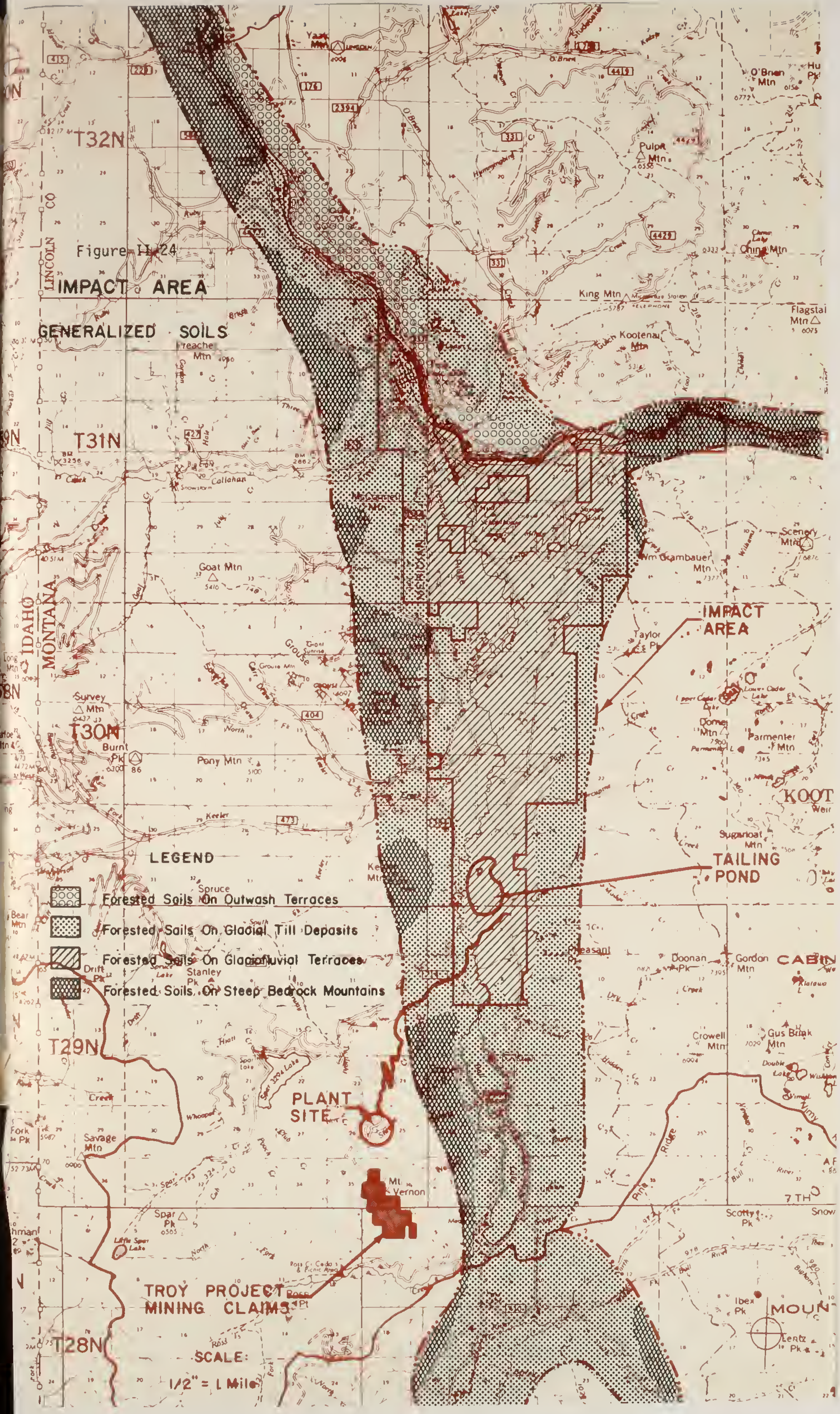


Figure II-24

IMPACT AREA

GENERALIZED SOILS

(1) Forested soils on outwash terraces - dominated by gently sloping to undulating shallow to moderately deep, gravelly and cobbly loam, silt loam and fine sandy loam underlain by gravelly and cobbly loam materials at 15 to 40 inch depths.

These soils are used mainly for forest products, although a few areas have been converted to dryland and irrigated hay and pasture. Most of the urbanization around Libby and Troy is on these soils.

(2) Forested soils on glacial till deposits - dominated by loamy soils containing various amounts and sizes of course fragments throughout the soil.

These soils are used mainly for forest products and recreation, although some areas have been converted to hay and pasture on the smoother slopes.

(3) Forested soils on glaciofluvial terraces - dominated by silt loam, sandy and loamy soils.

These soils are used mainly for forest products, although some areas have been converted to hay and pasture of which some are irrigated. Development in the Bull Lake area is predominantly located on these soils.

(4) Forested soils on steep bedrock mountains - dominated by soils shallow to bedrock and deep loamy soils containing a high percent of course fragments intermingled on steep and very steep mountain slopes.

These soils are used mainly for forest products and recreation. Land ownership is dominated by the United States Government and large corporations.

The soils of Lincoln County have generally been easy to deal with where shallow domestic water wells and individual sewage drain fields have been constructed (Montana Water Resources Board 1969). The large amounts of alluvial gravels deposited in major stream drainages account for both the abundance of groundwater and the rapid percolation rates.

Construction of water and sewer systems in the various soils of Lincoln County has not been found to be difficult. Pipeline trench digging in the sands and clay is extremely easy while the coarse stream gravels slow operations somewhat. Some bedrock has been encountered at normal water and sewer line installation depths.

c. Flood Plain

Lincoln County is in the process of delineating flood plains throughout the county for the purpose of adopting county flood plain regulations. The Lake Creek flood plain which lies within the intensive impact area is shown in Figure II-25. It is anticipated that flood plain controls will be adopted by the county in time to limit future development of this area. Other controls including review and approval of sewage systems and enforcement of streambank controls can also be used to limit growth in this area.

For purposes of determining the amount of developable land along the Lake Creek drainage, the area shown as flood plain has been deducted from the total acreage of "Other Private Ownership" to arrive at an estimate of developable land.

d. Summary of Land Capabilities

Overlays of land ownership, slope and flood plain were used to estimate developable land area within the Bull Lake impact area. Other private ownership which excludes ownerships of large corporations such as St. Regis and Burlington Northern were considered to be the available ownership category. Land with slopes ranging from zero to 15 percent were included and finally, all land within the flood plain was excluded.

Based upon this analysis, a total of 7,510 acres of land was considered to be available for development within the Bull Lake impact area. This includes approximately 150 acres which is already developed.

e. Land Use Planning

The following section presents a chronological history of major planning efforts in Lincoln County.

1970 - The LIbby-Lincoln City-County Planning Board was formed. Work was initiated on the development of a comprehensive plan for the jurisdictional area which extended approximately 4½ miles from the Libby city limits.

1972 - The Libby comprehensive plan was completed. The Lincoln County Planning Board was formed. This Board had planning jurisdiction of Lincoln County exclusive of the Town and the Libby planning area.

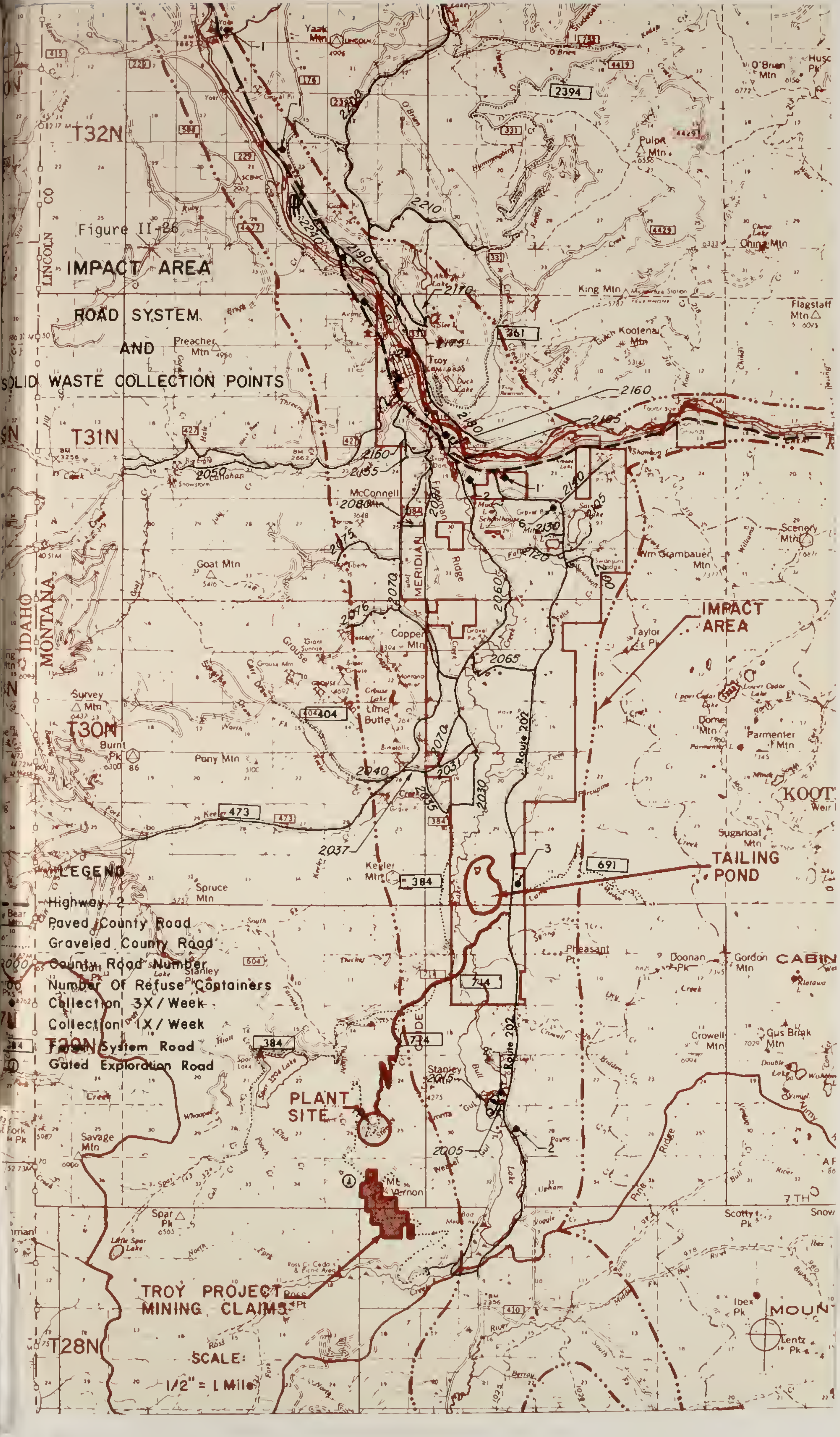


Figure II-26

IMPACT AREA

ROAD SYSTEM

AND

SOLID WASTE COLLECTION POINTS

1973 - A capital improvements program was completed and adopted by the City of Libby. Planning Staff was hired by the Lincoln County Planning Board.

1974 - The Libby City zoning ordinance was updated.
The Lincoln County Planning Board incorporated the County Department of Health and Environmental Sciences office with the County Planning office.
The county subdivision regulations were updated to comply with changes in the state regulations.
A county-wide resource analysis and land capability study was undertaken.
The development of a county comprehensive plan was initiated.

1975 - The Town of Troy was added to the County Planning Board jurisdiction.
Work continued on the planning efforts initiated in 1974.

1976 - The Libby-Lincoln City-County Planning Board was dissolved, placing the entire county under the jurisdiction of the County Planning Board.

1977 - The Lincoln County Planning Staff completed land use mapping in the Bull Lake area, a county-wide survey of attitudes with regard to transportation improvements, update and review of subdivision regulations and the development of a solid waste plan. In addition, the staff worked to develop interlocal agreements for area-wide sewage disposal, recreational development and animal control in the Libby area.

There are a number of regulations available to the City and County Governments that could be used to control development so that land uses are compatible with each other as well as with the capability of the land. These regulations are contained in Appendix P.

The mine and mill development proposed by ASARCO lies within the Bull Lake Planning Unit of the Kootenai National Forest (KNF). The land use plan for this unit is in progress. The inventories have been made and the alternative management displays prepared. A mailer containing this material was sent out in preparation for public meetings on the Planning Unit in June 1977. These meetings have been cancelled until the completion of the Roadless Area Review Reevaluation. Present plans call for the public meetings to be held in February 1979 and the draft ES for the Planning Unit to be issued out September 1979.

The Planning Unit contains a portion of the Scotchman Peak Roadless area, a 77,504 acre area along the Montana-Idaho border. The Scotchman Peak area was one of 274 roadless areas in the United States selected for further study as a new wilderness area. The Bull Lake Unit was to be the Planning Unit that would define the boundary of the Scotchman Peak area for further wilderness study.

The proposed mine and mill site is located 1½ miles east of the roadless area as it is now defined. The area between the mine and mill site and the roadless area is presently roaded and developed. Roads were built into the mine area in the 1960's for timber harvest. Mineral exploration in the late 1960's added more road development. Additional timber harvest is planned for the area and the potential for further mineral exploration is high.

At the time ASARCO filed their operating plan for the Troy project the Kootenai National Forest evaluated the alternatives of combining the Bull Lake Planning Unit environmental statement with the environmental statement for the mine and mill site or making a separate environmental statement for the ASARCO project. A decision was made to produce an ES for the ASARCO Troy Project separate from the ES for the Bull Lake Planning Unit. This was done because the detailed studies and site specific analysis required to evaluate the large and complex ASARCO proposal is not normally available in the land use planning process.

5. Social Structure and Social Services

a. Quality of Life and Social Values

In June, 1977, a private consulting organization gathered baseline information and conducted surveys and interviews with persons in the Troy area for the purpose of determining variables on quality of life important to the local people (T. A. P. Inc. 1978). The method and results of these most recent surveys as well as two previous surveys conducted in the area by other persons are contained in Appendix Q.

The forested mountains, lakes and streams provide almost unlimited recreational opportunities for area outdoorsmen. Many of the people live in and near Troy for this very reason. Recreational opportunities in the area include mainly fishing, hunting, swimming and camping. Also important activities are picnicking, hiking, boating, baseball and horseback riding. Other activities include biking, walking, distance running, waterskiing, snowmobiling and skating, and enjoying the peace and solitude of the mountains and woods. Troy residents highly value the environment.

The water quality of the area lakes and rivers is generally considered very good. Interviews conducted with residents revealed that they feel that presently water pollution in the area is slight. The basic concerns over water quality include inadequate sewage discharge surveilance, no sewage system and garbage accumulation along the rivers and lakes.

A slow pace, tranquility and friendly people--common to most small communities--is very evident in Troy. Outsiders and residents alike often speak of the friendliness and helpfulness of the people in the area. Although residents welcome outsiders, they don't want to see a large influx. Residents are adaptable generally within fairly wide parameters and are warm, friendly and generous people. The puritan ethic seems prevalent here in that most do hard work and have been a part or around this hard work most of their lives. Some of the most recent residents are living a very frugal existence.

Most of the people have lived in the Troy area a good deal of time and intend to live there for a long time. The community is basically a low to middle income class area with some wealthy retired people.

Troy's main activity centers around the logging industry. The noise from the logging trucks traveling through the town does distract from the quiet atmosphere, however, most residents are accustomed to this activity. There is adequate access to the area by major highways, bus service and also the Burlington Northern Railway.

Presently, the majority of people who are gainfully employed in the Troy region are employed, either directly or indirectly, with the forest products industry. Generally the people in the area are not prone to moving from place-to-place. Originally, most of the residents are from states other than Montana. The States of California, Minnesota and Washington rank highest in original homes for the people who now live in Troy.

The Troy area suffers high unemployment, with little permanent job opportunity for those coming out of high school. This is forcing many of the younger people to move away.

As mentioned previously, the residents of the Troy area, for the most part, are very self-sufficient people. They have no great needs for material goods, other than those that they have accumulated or have come with to the area. They point out that most of their purchasing of goods and services is done in the local area. The local availability of goods and services is minimal. The community of Libby (15 miles distant) has many more services and goods available than does Troy. Troy residents feel as though there is plenty of opportunity for retail and wholesale buying in the Libby area. In addition they point to the fact that there are numerous Idaho communities that are also reasonably close, including the major metropolitan center of Spokane, Washington.

One of the reasons the people in the Troy area are not overly concerned about additional opportunities for purchasing goods and services is that for many the marginal or extra dollar of buying power isn't present. The material needs of the Troy population generally does not appear to be high and those material goods that are necessities are available to the individuals in the local area. Buying power in general then could be described as being low, but since needs are low also, these two offset one another. With no banking facilities in Troy, most of the financial arrangements for any major purchase such as a car or home would have to be made in Libby.

The economy of the Troy region is tied to natural resources. The current economic opportunities in the Troy region are very limited. The overall base is small to begin with and in the past has experienced booms and busts that have heavily impacted the residents of the area.

The region is economically disadvantaged to some degree in that there is a high percentage of unemployed and not a lot of optimistic indicators in the future for an improvement. Enough economic means must be available to purchase those necessities and a few luxuries, otherwise the satisfaction level drops to the point where people will leave the area. Basically the residents of the Troy area would welcome a broadening of economic opportunity base in the area to enhance their own monetary situation and to strengthen the stability of the local economy.

In a community the size of Troy, with the limited economic base that Troy is experiencing, the level of public services are necessarily low. Health care, one of the very important variables in public services is extremely inadequate in Troy. There is no hospital and only very recently has there been a doctor available. Protective services such as police and fire are generally held in high regard in the Troy area. This is particularly true of the volunteer fire Department and fire dispatch capabilities. People in Troy are very proud of their rural fire Department and its abilities and response times. Police protection is considered to be adequate. Generally, residents are concerned about their education system and recognize problems stemming primarily from a lack of funding. The welfare system is envisioned as being adequate for their area. The people of Troy generally believe that the screening of welfare recipients is inadequate and that the system is poor and needs revision. Few residents currently participate in local government, however, it appears interest is increasing in this area. Most of the people indicated they had opportunity to participate in local governmental decisions.

People in the Troy area generally feel as though both state and national governmental controls are excessive. They indicate that the local government, while not having been too effective in the past, appears to be improving and will be more of a factor in the local region in the future. Residents do not want much control exercised over them by any agency or any other group of individual from outside the community. At the same time, however, they do mention the fact that local controls would be beneficial to the community.

There is a social organizational control prevalent in the society that exists in the Troy region. It is largely informal but is significant because groups of people with similar ideas have banded together in clubs and informal groups and have taken stands and have influenced activities that impact them at least locally and regionally. Most of the people in the area seem to think that the social organizational control is positively directed. In most cases it is aimed at local causes and in most cases they don't overstep what they construe to be their own bounds.

There is no radio station in Troy nor one that can be easily picked up by home receivers. The area does get television and the Missoula and Spokane papers are available. Also the "Western News" is available from Libby once a week. It was generally observed that Troy residents felt more adequately or well informed on what was going on in the world than they felt informed on what was going on in Montana. This is possibly because most of the people received the Spokane paper and television stations and therefore, get relatively little information on what is happening in Montana.

Due to its location, Troy may seem semi-isolated. The people in the area, however, feel there are more good points to this isolation factor than bad.

b. Social Services and Public Facilities

(1) Housing

The available housing and potential for housing development is evaluated for three areas within the mine impact area. These areas are delineated on Figure II-18.

(a) Troy Area

A housing inventory was conducted in the Troy area during July 1977. The inventory rated each structure's condition based upon a visual inspection of the exterior.

Table 1 shows the results of the Troy housing inventory (see Appendix R for methodology and rating system).

Table II-59 Condition of Housing - Troy Urban Area, July 1977

Unit	Good	Average	Condition Deteriorating	Substandard	Total
Single Family	-	66	183	112	361
Multi-Family	-	2	4	23	29
Mobile Home:					
Single	-	32	12	6	50
Park	25	7	9	-	41
Total	25	107	208	141	481

Nearly 73 percent of the housing in the Troy area is in deteriorating or substandard condition.

Over 75 percent of the existing housing supply in the Troy area is single family; mobile homes make up 19 percent and the remaining 6 percent is multi-family. There were approximately 20 vacant mobile home spaces within existing mobile home parks at the time of the housing survey.

(b) Bull Lake Area

An inventory of land use in the Bull Lake area was conducted by the Lincoln County Planning Staff in the fall of 1977. The inventory consisted of a field survey which inventoried residential and nonresidential development within the Bull Lake area. Table II-60 shows number of units and types of housing determined by the survey.

Table II-60 Housing Inventory - Bull Lake Area

Unit Type	Number of Units
Single Family Residential	109
Mobile Home on Single Lot	34
Mobile Home Park	4

The Bull Lake area has potential for residential development as shown in the Land Capabilities Section. The existing development is served by individual wells and sewage systems.

(c) Libby Area

A housing inventory was conducted in the Libby area in 1972. Table II-61 shows the results of that inventory.

Table II-61 Condition of Housing - Libby Urban Area

Unit Type	Standard	Condition Substandard	Total
Single Family	1,779	286	2,065
Multi-Family	148	45	193
Mobile Home	749	103	852
Total	2,676	434	3,110

Housing in the Libby area is in relatively good condition with 14 percent classified as substandard. The 1970 Census determined that there were 5,913 dwelling units in Lincoln County; based upon the two housing inventories, the Libby and Troy areas contain roughly 61 percent of the housing in the county.

A housing survey conducted by the Lincoln County planning staff in 1975 covered the entire county excluding the Libby city limits. This survey determined that 54 percent of the housing stock was in sound condition with 32 percent being classified as deteriorating and 14 percent classified as dilapidated.

A recent edition of the Western News, a weekly Libby newspaper, listed the following units for sale and rent in the Libby area:

FOR SALE:

15 Single Family Homes

5 Mobile Homes

FOR RENT:

7 Mobile Home Spaces

4 Apartments

There is very little developable residential land within the Libby city limits. Potential for new residential growth is greatest on the fringes of the urban area where additional land is available, especially in the west Libby area.

(2) Water Systems

(a) Troy

The town of Troy has a municipally owned and operated centralized water system that is supplied by O'Brien Creek and a well within the system. The combined capacity of these sources is 1,200 gallons per minute. Storage is provided by a 125,000-gallon tank located just south of the town. An additional 125,000-gallon storage would be required to provide adequate fire flows.

Distribution is provided by a 10-inch wood supply line from O'Brien Creek and a system of 8-inch mains feeding into 6-inch distribution lines.

(b) Bull Lake Area

Water systems in the Bull Lake area consist of individual wells. A recent well log map prepared by the Lincoln County Planning Staff shows existing wells ranging from 12 feet to 300 feet in depth in the area. There is abundant groundwater in the area, so that lack of potable water will not be a serious deterrent to growth in this area; however, as densities increase, the potential for groundwater pollution also increases.

(c) Libby

The Libby water system is a private utility owned and operated by Pacific Power and Light Company.

The source of supply is Flower Creek. A dam on Flower Creek about two miles south of Libby impounds five million gallons of water which is diverted into the Libby system. A supplemental reservoir has a capacity of 75 million gallons.

The distribution system consists of two primary feeder loops with a common 10-inch pipeline down Main Street. There is a considerable amount of 4-inch and smaller pipe in the system which is being replaced as needed with larger lines.

(3) Sewage Systems

(a) Troy

The town of Troy does not have a central sewage system. Private septic tanks and cesspools are the only sewage treatment at the present time. High levels of groundwater saturation occur during the spring of the year at which time pollution could occur in surface drainages. Since the town has a central water system, there is little danger of contamination of the domestic water supply. As densities increase, there may be a higher incidence of septic tank failures due to saturation of drain fields.

The town of Troy has relatively high priority for state and federal funds for planning and construction of a public sewage system.

The town is considering participating in the funding of a facility plan which would be the initial step toward the development of a centralized sewage system.

(b) Bull Lake Area

Individual septic tanks and cesspools are the only existing means of sewage disposal in the Bull Lake area. Along the Lake Creek Valley, there are a number of areas of high groundwater where conventional septic systems with drainfields would not be feasible. In addition, areas near streambanks and lake shores will not support individual systems that require the dissipation of effluent by draining it into the ground.

The general soil types along the Lake Creek Valley are forested soils and glacial till deposits and forest soils on glacio fluvial terraces. These soils generally provide adequate drainage for individual septic systems.

(c) Libby

The City of Libby has a municipally owned and operated sewage system. The treatment plant provides primary treatment and is designed to treat one million gallons per day. The plant consists of a clarifier, digester and chlorine contact chamber. The chlorinated effluent is discharged into the Kootenai River.

The South Libby Flats area is in the process of negotiating with the City of Libby for treatment of sewage from that area. The Libby treatment plant has been designed with adequate capacity to provide treatment for the surrounding urban area (design population - 6500).

(4) Transportation

(a) County, City Roads and Streets

An inventory of all roads maintained by Lincoln County was conducted in April 1975. Figure II-26 shows the County road system serving the intensive and extensive impact area. Information from that inventory is shown in Table II-62. The major county roads directly serving the mine site are Bull Lake Road and Lake Creek Road.

Bull Lake Road is functionally classified as a major collector.

Lake Creek Road provides an alternate connection from U. S. Highway 2 to the mine site access road. The route has a number of curves and is not competitive with Bull Lake Road in travel time from U. S. Highway 2 to the mine access route.

Lake Creek road is 20 feet wide with a penetration oil surface. The surface condition is good. The route is classified as a collector. Traffic volumes range from 100-150 vehicles per day. From the east Troy city limits to the Lake Creek Road junction with U. S. Highway 2 is approximately 0.7 of a mile less than to the junction of U. S. Highway 2 and Bull Lake Road.

Table II-62 County Road Inventory - Impact Area

Road Number	Road Name	Begins At	Ends At	Length	Surface Width	Surface Type	Function	Average Daily Traffic Count
2005	Bethal Drive	2000 MP 14.268	2010 MP 0.224	0.479	20	G 02	Collector	
2015	Halo Drive	2005 MP 0.161 (Running North)	2005 MP 0.161	1.138	20	G 02	Collector	
2030	Lower Lake Crk Road	2070 MP 6.800	2030 MP 0.649		24	G 02		
		2030 MP 0.649	2030 MP 0.989		16	G 03		
		2030 MP o.989	2035 MP 0.000	2.750	16	F 04	Local	
2031	Lime Butte - Keeler Creek Road	2070 MP 7.756	2030 MP 0.727	0.917	14	G 03	Local	
2035	Spar Lake Road	2030 MP 2.750	2037 MP 0.121	1.005	16	F 03	Local	
2037	Keeler - Rattle Road	2031 MP 0.000	2038 MP 0.000	0.724	20	G 02	Local	
		2070 MP 7.756						
2040	North Fork Keeler Rd	2038 MP 0.126	Residence	0.793	16	G 02	Local	
2050	Callahan - Iron Crk	Callahan Road	Callahan Creek	2.230	14	F 04	Local	
2060	Lake Creek Road	U. S. 2	2070 MP 5.955	5.054	20	G 02	Collector	114 - 148
2065	Chase Cutoff	2000 MP 5.352	2060 MP 4.383	2.033	18	G 02	Local	
2070	Iron Creek Road	U. S. 2	2037 MP 0.000	7.756	20	G 02	Collector	40 - 121
2075	Iron - Grouse Road	2070 MP 3.036	2075 MP 1.673	1.673	14	P 04	Local	
2076	Pattie Hill	2070 MP 3.971	Residence	1.027	16	G 03	Local	
2080	Cox Lane	2070 MP 2.344	2081 MP 0.000	0.455	20	G 03	Local	
2081	Keeler Road	2080 MP 0.459	2070	1.287	24	G 02	Local	134
2100	Swanson Lodge Road	2000 MP 3.008	Residence	0.970	14	G 02	Local	
2105	Falls Creek Road	2000 MP 2.779	2105 MP 0.137		14	G 02		
		2105 MP 0.137	Residence	0.872	12	P 04	Collector	
2120	Milner Lake Road	2000 MP 2.779	Residence	0.447	16	G 02	Local	
2130	Milner Lake Cemetery	2000 MP 2.484	Residence	0.360	14	F 02	Local	
2140	Shannon Road	2000 MP 1.687	Gravel Pit	1.530	14	G 03	Local	
2150	Snapperville Road	2070 MP 0.506	U. S. 2	1.665	24	G 02	Collector	239
2155	Sloan Spur	2150 MP 0.662	Residence	0.130	24	G 02	Local	
2160	Landfill Road	U. S. 2	Troy Dump	0.428	18	G 03	Local	
2165	Lk Crk Substation Rd	U. S. 2	2165 MP 0.144	0.144	14	P 03	Local	
2170	TV Tower Road	2175 MP 1.000	TV Tower	0.600	14	P 03	Local	
2175	Ninneman Road	2200 MP 0.391	Residence	1.296	14	G 02	Local	
2180	Kootenai River Road	2190 MP 2.814	2180 MP 1.265		18	G 02		
		2180 MP 1.265	Residence	1.890	14	G 03	Local	
2190	Old U. S. 2 South	U. S. 2	Troy Bridge	2.814	18	G 02	Local	
2200	Kilbrennan Lake Road	2190 MP 1.859	2200 MP 3.940		18	G 03		
		2220 MP 3.940	2200 MP 7.550		20	G 03	Collector	
		2220 MP 7.550	Kilbrennan Lk	10.260	16	G 03		
2210	O'Brian Creek Road	2200 MP 1.854	Residence	3.079	16	F 03	Local	
2240	Old U. S. 2 - MIddle	2230 MP 0.000	U. S. 2	1.518	18	G 02	Collector	

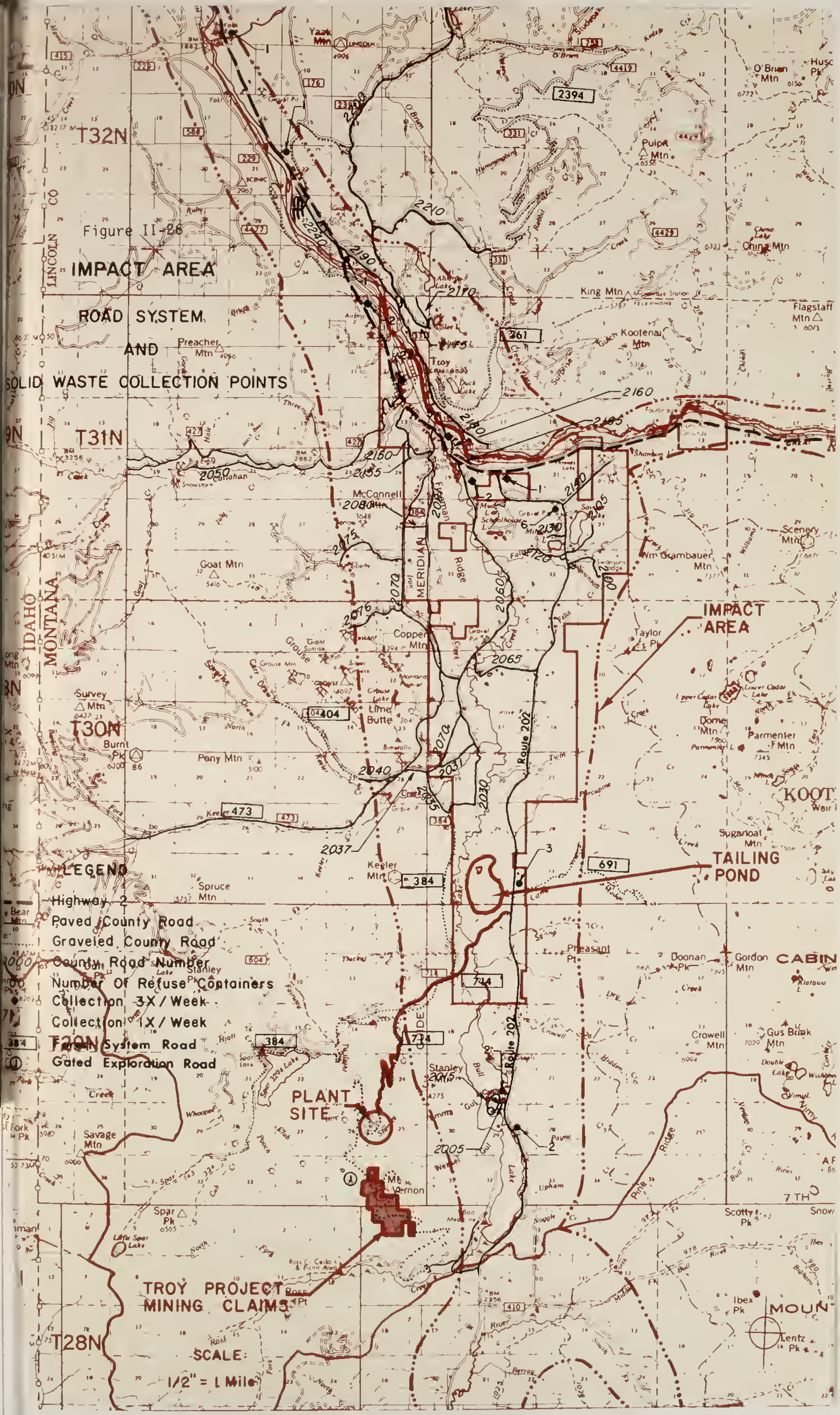


Figure II-26

IMPACT AREA

ROAD SYSTEM

AND

SOLID WASTE COLLECTION POINTS

The major streets serving the town of Troy are: 1) Missoula Avenue which is the section of U. S. Highway 2 which passes through the town. This street is lined with highway commercial establishment north and south of Troy and within the Troy city limits, 2) Third Street which is the major east-west access street and the only street crossing the Burlington Northern Railroad tracks within the city limits, 3) Kootenai Avenue along which the central business distinct is located and 4) Riverside Drive, the major north-south access street east of the Burlington Northern Railroad tracks.

Libby is presently in the process of implementing a street improvement plant. Storm sewer, street, curb and sidewalk will be constructed on a number of the residential streets in the city. There has been a significant amount of street and highway construction in the Libby area in the past decade. U. S. Highway 2 has been reconstructed east and west of Libby. Mineral Avenue which serves the central business district has been reconstructed and other improvements have been made in the area.

(b) Highways

Route 202 is the nearest principle route from which the proposed mine could be accessed. Route 202 starts at Route 200 near Noxon and extends 35 miles north to a junction on Route U. S. 2, three miles east of Troy and 15 miles west of Libby. The road is a major north-south arterial route in western Sanders and Lincoln Counties.

The surface on Route 202 is plant-mix asphalt with a width of 24 feet on the section constructed in 1956 and 1960 beginning at its junction on Route U. S. 2 and continuing south for 12.5 miles. The remainder of the highway was constructed in 1963 and is 28 feet wide.

The adjusted sufficiency ratings for the newer section is 71, the older sections built in 1956 and 1960 have a rating of 63 and 62 respectively. The adjusted sufficiency rating has been computed to establish priorities for sections of highway falling into the same general sufficiency rating category. The total basic sufficiency rating is adjusted by comparing the average daily traffic carried by the rating section, with the average for the system. Mileage rated between 61 and 100 percent sufficient is considered to be tolerable to excellent (Montana Department of Highways 1976).

The Montana Department of Highways plans to build a new weigh station in the southeast quadrant of the intersection of Route U. S. 2 and Route 202 to replace the existing weigh station east of Libby. Work will include a new scale house, scale, ramps, signing, lighting and acceleration and deceleration lanes on Route U. S. 2.

No specific weight restrictions have been assigned to the sections of Route 202 and Route U. S. 2 affected by the proposed mine, although the Montana Department of Highways maximum weights and dimensions standards apply to specific types of trucks, tractors and trailers. Seasonal weight restrictions may be imposed in the spring months to protect the road during the spring thaw.

Noise readings were taken by the Department of Highways on July 20, 1977 at a total of six locations along U. S. 2 and Route 202 (Figure II-27) and are representative of noise sensitive areas in the project area with one exception; location No. 1 was taken near the end of the proposed haul route and was not used in the final analysis because of minimal traffic and unusual, non-relative noise. Locations No. 2 and 3 were taken near residences in commercial areas within the city limits of Troy. Locations No. 4, 5 and 6 were taken at selected residences along Bull Lake Road.

The following measurements and projected measurement were obtained for each location:

Table II-63

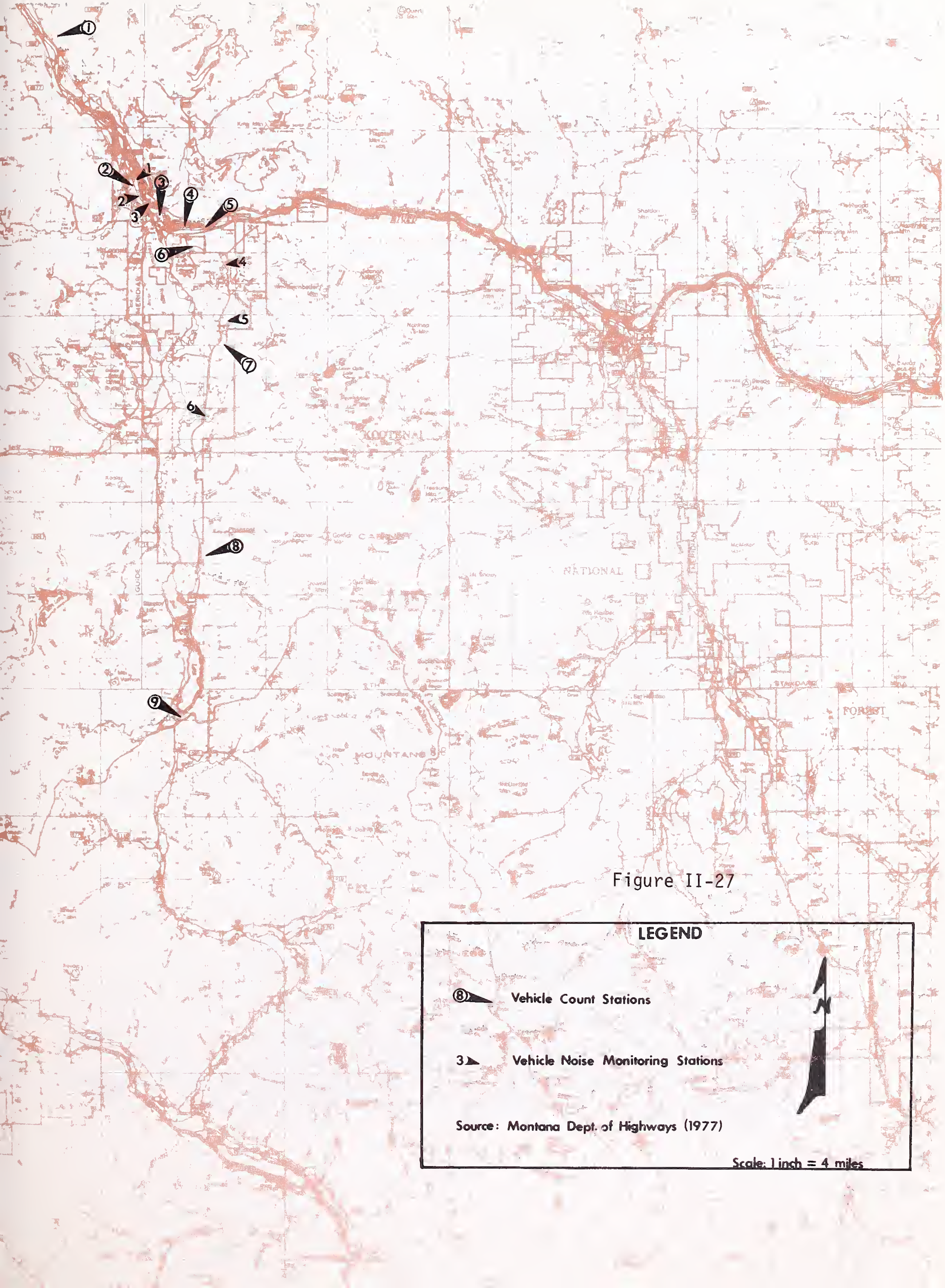
Location *(L_{10} dBA)	1977 (measured)	1999 (normal growth only)
No. 2	65	72
No. 3	69.5	76
No. 4	56	60
No. 5	56	60
No. 6	56	61

*Noise level exceeded 10 percent of the time (maximum limit: Residential = 70 dBA and Commercial = 75 dBA).

Traffic counts made by the Montana Department of Highways during February 1977 at nine stations along Route U. S. 2 and Route 202 are contained in Table II-64.

Table II-64 Montana Department of Highways Vehicle Count Data for Nine Stations along Route U. S. 2 and Route 202, February 1977

Location		Average Daily Traffic
Site No. 1	Four miles South of 508	1204
Site No. 2	South of Airport	2060
Site No. 3	City Limits	3138
Site No. 4	West of Route 202	1986
Site No. 5	East of Route 202	1831
Site No. 6	At Route U. S. 2	720
Site No. 7	Four miles South of Route U. S. 2	418
Site No. 8	Three miles North of Line	371
Site No. 9	Sanders County Line	290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⑧
⑨
1
2
3
4
5
6
KOOTENAI
CABINET
NATIONAL
MOUNTAINS
FOREST
MERIDIAN
GUIDE
LEGEND
⑧ Vehicle Count Stations
3 Vehicle Noise Monitoring Stations
Source: Montana Dept. of Highways (1977)
Scale: 1 inch = 4 miles

Figure II-27

Route U. S. 2 between Libby and Troy was constructed during the mid 1930's and does not meet present design standards. Plans are under way to reconstruct this section of road except for two miles of four-lane highway west of Libby which was built in 1971 and improved in 1976. Completion of reconstruction is anticipated to occur in the mid 1980's.

The new section of Route U. S. 2 will closely follow the existing roadway with deviations to improve the horizontal and vertical alignment. The finished surface width will be 40 feet with a design speed of 60 miles per hour. Traffic counts made by the Department of Highways in 1976 on the present section indicate that approximately 2006 vehicles per day travel between Troy and Libby. Forty-four percent of the vehicles were trucks and pickups with 15.8 percent of the traffic being trucks, 18.2 percent pickups and the remainder passenger cars.

The Department of Highways plans to build a new weigh station in the southeast quadrant of the intersection of Route U. S. 2.

(c) Forest Roads

The Forest Service system roads feed into the county road system (Figure II-26). These roads were built primarily as access roads for timber harvest. The roads were designed to carry heavily loaded logging trucks safely at relatively low speeds. The roads were built with native material with a dirt or pit run gravel surface, with a 14 foot running surface and turnouts. Basically the roads require a low speed, and have a low volume of traffic, are dusty during the dry months and are muddy during the wet months. The roads are not designed or built for sustained year-round use by heavy traffic. Road use is restricted during portions of the year, such as spring breakup and periods of heavy continued rain. An oil dust coat is applied to sections of these roads when log hauling is to be done during the dry periods of the year.

Present use of the roads is for recreation administration and occasional periods of heavy logging traffic. Spur roads of a lower standard built off these system roads for logging are generally closed upon completion of logging.

(d) Airports

The Troy airport is owned by the Forest Service and under Special Use Permit to Lincoln County for operation and maintenance. The airport is located along the Kootenai River approximately one mile north of Troy. The airport consists of one 2,600 foot by 50 foot paved runway. The airport has no lighting, radio or navigation aids. Fuel and ground transportation are not available at the site.

The Libby airport is located eight miles south of town. The airport is jointly owned and operated by the City of Libby and Lincoln County. Facilities include a 4,200 foot by 75 foot paved runway which is designed for wheel loads up to 30,000 pounds. Runway lights and a fuel supply are provided.

Limited charter service is offered at the Libby airport but not on a regular basis.

The Libby airport was constructed by the Corps of Engineers to serve air transportation needs during the construction of Libby Dam. The airport can accommodate small jet aircraft and some air cargo transports.

(e) Railroads

Burlington Northern Railroad provides direct, east-west rail service to Libby and Troy. Passenger service is available from Libby. AMTRAK service is available four days a week, one train per day to points east and west.

(f) Bus

A private carrier, Brown Bus Lines provides passenger and limited freight service along U. S. Highway 2. This bus line serves both Libby and Troy and provides passenger service to/from Kalispell.

Libby has a senior citizen bus that provides transportation for members of the local senior citizens organization.

(g) Taxi

The communities of Libby and Troy have taxi service. The Libby Cab Company operates two vehicles. The Troy operation has one vehicle.

(5) Solid Waste Collection and Disposal

Solid waste collection and disposal in Lincoln County is administered by the Lincoln County Refuse Board.

Collection is carried out by two contract refuse transporters utilizing a container or "green box" collection system.

The solid waste management program administered by the Lincoln County Refuse Board also funds the operation of two permanent landfill sites and two temporary sites.

(a) Troy and Bull Lake Areas

Household refuse in the Troy and Bull Lake districts is disposed of by means of a "containerized" system. A number of green four to six-yard containers are distributed throughout those areas in relatively convenient locations. These boxes are emptied with regular frequency into a front-loading refuse packer which, in turn, transports the compacted refuse to the Libby sanitary landfill. The location of these boxes and the frequency of pickup are noted on Figure II-26. The rural areas surrounding Troy are serviced once per week and the more heavily congested areas, such as the town of Troy, are serviced four times weekly.

Refuse is transported from the Troy and Bull Lake areas to the Libby landfill which is located approximately 3.5 miles north of Libby. The site is 40 acres in size and has a projected life of 35 to 40 years of continuous operation. The landfill is located on U. S. Forest Service land and therefore, requires the continued issuance and review of the Special Use Permit by the U. S. Forest Service.

(b) Libby

The City of Libby and its immediate surrounding area is serviced by a private contractor operating independent of the refuse district. Solid waste is transported to disposal at the Libby landfill site.

As of May 1974, the Lincoln County Board of Commissioners have established a wrecked motor vehicle removal program as provided by enabling legislation and funding. Lincoln County is embarking on a two-year intensive removal program. To date, approximately 1,700 cars have been collected, crushed and removed to recycling centers. This program also is designed to control the expansion of private wrecking facilities, to ensure proper screening and licensing.

Three permanent wrecked motor vehicle disposal sites have been established, one each at the Libby and Eureka landfill sites and one at the abandoned open dump located approximately two miles east of Troy.

(6) Schools and Student Transportation

(a) Troy

The Troy School District includes two school buildings, both located within the limits of the City of Troy. The W. F. Morrison Elementary School houses grades Kindergarten through Eighth and had a total enrollment of 407 pupils for the 1977-1978 school year. Troy High School houses grades Ninth through Twelfth and had a total enrollment in the fall of 1977 of 218.

The Troy elementary school is situated on a 4.8-acre site centrally located within the town. The recommended site size for an elementary school of this size is between seven and eight acres. The apparent deficiency in site size is somewhat offset by the proximity of the school ground to the Troy City Park. Consequently, in view of the fact that there is not a great demand for expansion of the school buildings (as indicated by the Enrollment/Capacity Table II-65), it appears that the school site is adequate to accommodate existing demand and normal growth at least through 1995.

The playground area (which adjoins the city park) is furnished with a variety of equipment including swings, slides, teetertotter and a few other miscellaneous items typically associated with elementary school play areas. The playground and equipment are in fair to good condition.

The school actually consists of three buildings, the first phase being constructed in 1915 and 1917 with major additions and modernizations in 1963 and 1967. Building materials used in the structure include concrete block, brick and wood frame, encompassing an area of 39,240 square feet. The building is considered to be in good to excellent condition and recently, plans have been initiated for an addition to the school to accommodate special school functions and physical education classes. The proposed multi-purpose building addition will provide approximately 9,000 square feet of space with provisions for a modern kitchen, extra storage room, and boys and girls locker rooms. The plan also calls for two additional classrooms separate from the multi-purpose building.

Classroom space for grades Kindergarten through Eighth is adequate to handle the existing enrollment plus an average of about 15 pupils per classroom to reach maximum capacity for the school. Enrollment in 1977 is 407 pupils compared to a total capacity of 549. Available expansion within the school building is limited to one room, but the school site can provide for the future expansion of six to eight classrooms.

Troy High School borders on U. S. Highway 2 near the north edge of town and consists of five acres of land of which approximately 13 percent is occupied by builings.

Construction of the original Troy High School began in 1917. Additional space was added in 1950, 1958 and 1975. Total building area is 28,263 square feet. Construction consists of frame and brick, frame and concrete blocks with laminated wood beams. The condition of the building ranges from fair to excellent depending upon the period of construction.

The available school yard area covers 1.1 acres. This area includes a baseball field and basketball court.

Table II-65 compares classroom capacity to existing and estimated class enrollments.

The Troy School District provides transportation for students living in the outlying areas, using six district-owned buses with a total capacity of 415 (Figure II-28). The six buses travel a total of 62,020 miles per year at a total cost of $39,014.78 or approximately 63 cents per mile.

At the present time, one bus run covers the Bull Lake Road as far south as the Road and Gun Club. The mine impact may necessitate an additional bus on this run. Based upon the average annual mileage, the cost of an additional unit would be $6,512 per year.

(b) Libby

The Libby School District is served by a senior high school, junior high school and six elementary schools.

Table II-65 Existing and Projected Enrollment Information for the Troy and Libby School Districts

Troy School District

School Year	Elementary	High School	Total
1977-1978 (actual)	407	218	625
1980-1981	504	270	774
1985-1986	563	302	865
1990-1991	563	302	865
1995-1996	563	302	865
Capacity (1977)*	549	300	849
Surplus/Deficiency	-14	-2	-16
New Teachers Required	10.0	4.5	14.5

*An addition of six to eight rooms is presently underway.

Libby School District

School Year	Elementary	Junior High	Senior High	Total
1976-1977 (actual)	1,452	770	714	2,936
1980-1981	1,596	847	785	3,228
1985-1986	1,640	870	807	3,317
1990-1991	1,649	875	811	3,335
1995-1996	1,658	880	815	3,353
Capacity (1972)	2,070	1,200	1,020	4,290
Surplus/Deficiency	+412	+320	+205	+937
New Teachers Required	10.0	6.0	6.5	22.5

Plummer School is located about two miles west of town on Indian Head Road and just south of Highway 2. Its location is well-suited for serving the needs of the surrounding residential areas. The area around the school is desirable for present and future residential developments. The site size, 11.60 acres, is above the minimum recommended by the Board of Health.

McGrade School is located four miles south of Libby in the White Haven area. The area south of Libby, including White Haven, is expected to undergo the most severe population losses as dam construction declines. The site size, 23.55 acres, is adequate.

Asa Wood School is located at the western edge of town, at the end of Lincoln Boulevard. Asa Wood occupies a 9.45-acre site which is above

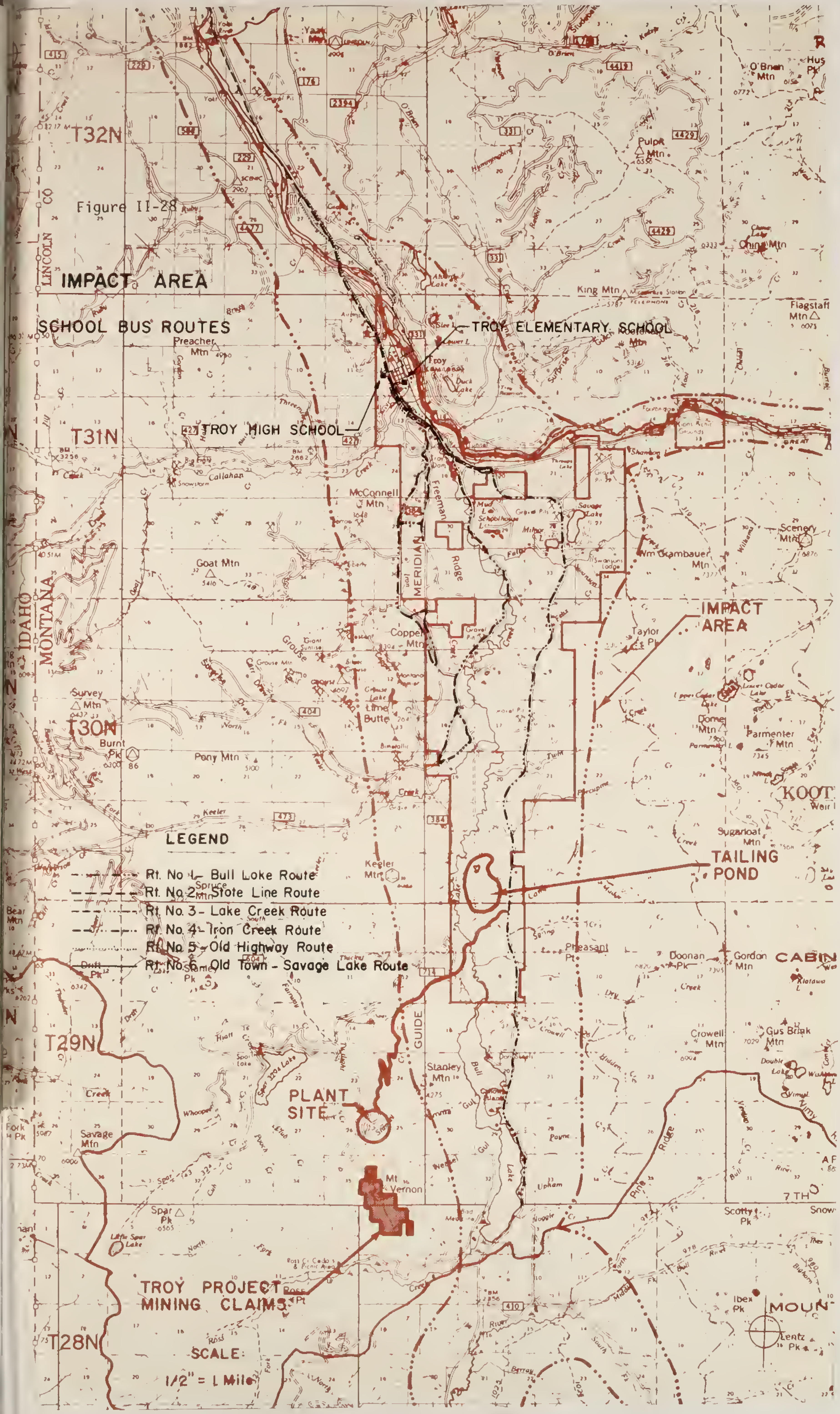
Figure II-28
IMPACT AREA
SCHOOL BUS ROUTES
TROY ELEMENTARY SCHOOL
TROY HIGH SCHOOL
IMPACT AREA
TAILING POND
PLANT SITE
TROY PROJECT MINING CLAIMS
LEGEND
Rt. No. 1 - Bull Lake Route
Rt. No. 2 - State Line Route
Rt. No. 3 - Lake Creek Route
Rt. No. 4 - Iron Creek Route
Rt. No. 5 - Old Highway Route
Rt. No. 6 - Old Town - Savage Lake Route
SCALE:
1/2" = 1 Mile
T32N
T31N
T30N
T29N
T28N
IDAHO
MONTANA
LINCOLN CO
Troy
Mt Vernon
Preacher Mtn
McConnell Mtn
Goat Mtn
Keeler Mtn
Stanley Mtn
King Mtn
Pulpit Mtn
China Mtn
Scenery Mtn
Wm Grambauer Mtn
Taylor Pk
Dome Mtn
Parmenter Mtn
Sugarloat Mtn
Pheasant Pt
Doonan Pk
Gordon Mtn
Crowell Mtn
Gus Brink Mtn
Scotty Pk
Ibex Pk
Lentz Pk
Spar Pk
Savage Mtn
Burnt Pk
Survey Mtn
Pony Mtn
Copper Mtn
Lime Butte
Savage Lake
Kootenai
Freeman Ridge
GUIDE MERIDIAN
Bull Lake
Pine Ridge
CABIN
MOUN

the recommended minimum, but below national averages. Vacant land is available west of the school, should more be required.

The Central School complex consists of three buildings, housing Lincoln Elementary School Central Elementary School and Memorial Gymnasium. The present location, one block north of Highway 2 between Mineral and Louisiana Avenues, allows the Central School complex to serve most of Libby. While the site area, 7.0 acres, is slightly above the minimum recommended, it is well below national average.

St. John's Lutheran School is a private elementary school located in the southern part of Libby. This small (six classrooms) church-supported institution occupies two acres adjacent to a park. At full capacity and with adequate staffing, this school could handle 150 to 200 pupils. Present enrollments are much fewer than this. This private school compares favorably with the public schools in terms of location, site size and general suitability.

Libby High School is located one mile northwest of the city close to U. S. Highway 2. Access to the school site and parking are adequate. A county road completed, will greatly facilitate traffic flows in the area. The site area, 22.06 acres, is lower than both recommended minimums and the national average.

Ski-Dale Junior High School is a junior high school which was constructed in 1969. The school has 35 acres available for expansion, or outdoor recreation facilities. The buildings are about one mile southwest of town, near both present and future areas of development.

Transportation for the Libby School District is provided by a fleet of 19 buses with a combined capacity of 1,212 passengers.

(7) Public Safety

Public safety within the impact area is provided by the Lincoln County Sheriff Department, Troy City Police Department, Libby City Police Department and the Montana Highway Patrol.

(a) Lincoln County Sheriff Department

The Lincoln County Sheriff's office and county jail are located in the Lincoln County Courthouse on California Street in Libby. The Courthouse was built in 1933 and is of masonry construction. The building is in fair condition. The facility has two cell areas capable of holding 20 prisoners. The Department has seven patrol cars, 15 sworn personnel and nine non-sworn personnel. The Libby Fire and Ambulance calls are dispatched through the Sheriff's office.

The Sheriff's office is funded by the county budget. The 1977-1978 budget for the Sheriff's office is $299,650. The Department is reasonably well equipped, although additional equipment is needed as well as replacement of some of the existing equipment.

(b) Libby City Police Department

The Libby City Police Department and jail are located in the Libby City Hall on Mineral Avenue. The Libby City Hall was built around 1930 as a WPA project and is of brick construction. The facility contains two cell areas. The Department operates its own dispatch system and has two vehicles, nine uniformed officers and five dispatchers.

The Department is funded primarily by city budget. Some federal assistance is obtained from CETA funding. The equipment is generally in good condition, although an additional jail cell is needed.

(c) Troy City Police Department

The building in which the Troy City Police Department and jail are located is of masonry construction and has undergone extensive renovation in 1977. The facility contains two cell areas. The Department has two vehicles and the dispatch system handles police, fire and ambulance calls. The staff consists of a police chief, three patrolmen and one clerk.

The Department is funded through the city budget, CETA and Crime Control funds. The present city budget for the Department is approximately $27,600 CETA funds supply salaries for the three patrolmen and the clerk. Crime Control funds are used for equipment purchases and overtime pay.

(8) Fire Protection

Fire protection in the impact area is provided by the Troy and Libby Volunteer Fire Departments.

(a) Troy Volunteer Fire Department

The building housing the Fire Department was constructed in about 1972 and is of cinder block construction. The building is in good condition and access to the site is good. Equipment ownership is divided between the city and county. Needed equipment is used regardless of the location of the fire. All equipment is in good condition. The Department has two pumper trucks, one tanker and a half-ton truck with a portable pumper. The Department is staffed by 28 volunteer firemen and responds to approximately 120-180 calls per year. Approximately 24 of these calls are false alarms and 24 would non-fire rescue type calls. The City Department responds to fires within a five mile radius from the center of town. The Libby Volunteer Fire Department and the Forest Service will respond as backup units if needed.

The Department is funded in part by mill levy and fund raising programs. It costs approximately $800-1,200 per year to operate the City Fire Department.

(b) Libby Volunteer Fire Department

The Libby Volunteer Fire Department is located adjacent to the Libby City Hall. The Fire Department addition to the Libby City Hall was constructed in 1962 and is of concrete block with wooden beam construction. The building is in good condition and access to the site is good.

Equipment ownership is divided between city and county. Rural equipment is used for city fires if needed. All equipment is in good condition. The Department has 4 pumpers, 3 tankers, 1 truck, and 1 utility van. Shared equipment includes self-contained breathing apparatus and resuscitators. The Department is staffed by 28 volunteer firemen.

The Fire Department averages 150 calls per year. Approximately 15 of these are false alarms and five are non-fire rescue calls. The City Department responds to fires within the city limits. The Rural Department responds to fires within a five-mile radius of the fire station. Both departments will respond to calls outside their jurisdiction with limited manpower when they are needed. Fire calls are dispatched through the Sheriff's Department. There is a mutual aid policy between the Libby Volunteer Fire Department and the St. Regis Paper Company.

Approximately $2,000-$2,500 for equipment is obtained through donations and an annual Fireman's Ball. Additional equipment, maintenance, and operational funds come from city budget and Rural Fire District budget.

(9) Welfare and Social Services

(a) Public Welfare

The Lincoln County Department of Public Welfare provides economic assistance and welfare programs for residents of the county. The Public Welfare Office is located in the County Courthouse in Libby. Appendix S contains a summary and brief description of the welfare assistance programs available in Lincoln County.

(b) Social Services

The Social Services Program of the Welfare Department is supervised by the Community Services Division of the Department of Social and Rehabilitation Services. A comprehensive listing of the Social Services available in Lincoln County is summarized in Appendix S.

(10) Health Services

(a) Health Care Personnel

Eight percent of the persons residing in Troy listed lack of medical facilities as one of the problems in the Troy area (Appendix Q).

At the present time, there is approximately one physician per 1,300 persons in the impact area. This compares to a common standard of 1,222 persons per physician.

Presently, the impact area is served by the following medical personnel:

Chiropractors residing in Libby	2
Pharmacists residing in Libby	7
Pharmacists residing in Troy	1
Optometrists residing in Libby	2
Physicians residing in Libby	8
Pediatricians (1)	
Surgeons (1)	
Internists (1)	
General Practitioners (5)	
Physicians residing in Troy	2
Internist (1)	
General Practitioner (1)	
Osteopaths residing in Libby	1
Speech Pathologists residing in Libby	3
Speech Pathologists residing in Troy	1
RN's residing in Libby	41
RN's residing in Troy	3
LPN's residing in Libby	14
LPN's residing in Troy	1
Physical Therapists residing in Libby	1
Dentists residing in Libby	6
Dentists residing in Troy	1

(b) Hospitals and Ambulances

Hospital care in the impact area is provided by St. John's Lutheran Hospital which is located at 350 Louisiana Avenue in Libby.

St. John's Lutheran Hospital was built in 1952. It is of concrete and block construction. The downstairs area was remodeled in 1973 for radiology, laboratory, and out-patient waiting area expansions. The building is in fair condition. Access to the site is good with off-street parking available for staff members. There is no off-street parking available for visitors. Room is available on the site for expansion if needed. There is also a heliport located on the site.

The hospital is well equipped. All equipment is in good to excellent condition. The hospital contains a lab section, radiology, computerized EKG, emergency, surgery and obstetrics facilities.

There are no doctors on the hospital staff. There are about ten doctors in the community who use the facility. There are 15-20 RN's, 3 LPN's, 8-12 aides, 7 office personnel, 2 respiratory therapists, 3 x-ray personnel, 3 lab personnel, 1 janitor, 2 housekeepers, and 6 kitchen personnel.

The hospital serves the south Lincoln County area. The hospital has 34 beds including four for children and eight for maternity. The present average occupancy rate is 35%.

Funds are generated from patient revenue. Approximately 75 percent of collections come from 3rd party reimbursements such as AETNA and Blue Cross. Medicare patients are accepted. Operational costs are approximately $600,000 per year.

The Troy Volunteer Ambulance provides emergency medical services for Troy and the surrounding area. At present the Troy Volunteer Ambulance service houses one ambulance in the fire hall. The fire hall is about five years old, of cinder block construction, and is in good condition.

The Troy Volunteer Ambulance equipment meets the State of Montana* requirements. All equipment is in good condition. Each ambulance can accommodate a driver and two attendants.

The ambulance service has the following vehicles:

Year	Make	Type of Unit	Capacity
1972	Ford	3/4 ton Van	4 stretchers
1976	Dodge	Modular	3 stretchers

Each ambulance is equipped with two radios; one is on Police Band and the other is a HEAR system. The HEAR system gives the capability for telephone hookup and can be used for ground-to-helicopter communication.

At present, the Troy Volunteer Ambulance service has 22 trained members and one trainee. The ambulance service responds to approximately 150 calls per year. Roughly 50 percent of the calls are for elderly people. Other types of calls consist of auto accidents, community accidents and sickness.

The service serves the area between Troy and Idaho, the Yaak River, Bull Lake Road to the county line and the area towards Libby. If back-up units are needed, the Libby ambulance will respond.

The ambulance service receives some funding from the Department of Health through the county. Federal grants have been available but are lessening off. Donations and collections make up the remainder of the funds. Operational costs are about $3,000 per year for supplies, gas, and repairs.

The ambulance services available in Troy and Libby areas are very good. All of the vehicles are well equipped. All attendants are well trained and many of them are licensed Emergency Medical Technicians.

The ambulance service needs additional space where both ambulances along with equipment can be located.

The Libby-Troy Volunteer Ambulance Service is located on Montana Avenue in Libby. The ambulance building is of wood frame construction. There is a separate training room within the building. The building is in good condition and access to the site is good.

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*Montana Department of Health and Environmental Sciences, Emergency Medical Services Bureau.

The Libby-Troy Volunteer Ambulance equipment meets the State of Montana requirements. All equipment is in good to excellent condition. Each ambulance carries a driver, an attendant and a trainee.

The ambulance service has the following vehicles:

Year	Make	Type of Unit	Capacity
1964	Ford	Rescue Extrication Van	
1967	Chevy	Suburban	2 stretchers
1972 or 73	Chevy	Van	4 stretchers
1975	Chevy	Van, modular body type	4 stretchers

Each ambulance is equipped with a Police Band radio and a HEAR system. A new ambulance will be needed in about two years.

At present, the Libby-Troy Volunteer Ambulance service has 31 trained members and six trainees. The Libby-Troy Volunteer Ambulance responds to approximately 250 calls per year. Roughly 25 percent of the calls are for elderly people. Other types of calls consist of out-of-town auto accidents, community accidents, heart attacks, and other emergencies.

In general, the ambulance responds to calls half-way to Troy. If needed, they will respond farther. The extrication unit will respond to calls wherever it is needed. There are usually three volunteers on call for each 24-hour period. If additional ambulances are required in the Libby area, St. Regis Paper Company or W.R. Grace and Company will respond. St. Regis Paper Company has two ambulances and W.R. Grace has one ambulance.

Approximately two-thirds of the operational costs are obtained from service billings. A county grant, donations, and memorial contributions make up the remainder of the budget. It costs approximately $300 per month to keep the ambulance in operation.

(c) Extended Care Facilities

The Libby Convalescent Care Center provides long-term care for persons within the impact area. The center was constructed in 1970 and is in good condition. Access to the site is good, and off-street parking is available for employees and visitors. The site has ample area for expansion. The facility contains a multi-purpose day room, lounge, smoking room, treatment room, beauty shop and staff offices.

There is one doctor on staff part time who acts as advisor and medical director, and who will take over if a patient's own doctor is not available. The nursing staff consists of one full-time and three part-time RN's, and five full-time and three part-time LPN's. There are 25 full and part-time aides. Office staff consists of an administrator and secretary-bookkeeper. Other staff includes a janitor, a yard boy, housekeepers, laundry workers, a kitchen supervisor, cooks and tray girls. A consultant pharmacist works at the facility twice a week. Physical and speech therapists come to the facility when needed.

The center is privately owned and serves the Lincoln County area. There are 63 beds with 100 percent occupancy. Vacant beds are filled from a waiting list. All patients must be referred to the center by a doctor in the county. Twenty-four hour skilled nursing care is provided. Patients include ambulatory and non-ambulatory patients ranging in age from 16 to 101. Patients who are able can attend the Sheltered Workshop. Many patients are on social security. About two-thirds of the patients receive Medicaid. The center will also accept Medicare patients. There is presently a waiting list of six to eight persons.

A new addition is planned for the facility. It will contain seven bedrooms which can accommodate 16 more beds. It will also contain a therapy room, a dining-day room, a smoking room, storage and utility rooms, and offices.

(d) Mental Health Facilities

Mental health services in Lincoln County are provided by the Western Montana Regional Medical Health Center. Mental health services are availble to all residents of Lincoln County. Services include outpatient care, consultation and education, and emergency services. The Center's work is typically in the areas of behavioral problems, marital conflicts, and emotional distress. Staff consists of the director and a mental health worker. A psychiatrist visits the Center once a month and a local physician serves as medical consultant.

6. Archeological and Historic Sites

During August and September of 1976, an intensive archeological reconnaissance was made of the U.S. Department of Agriculture land in the Troy Ranger District. A detailed description of the method of survey and an ethnographic account of the native people of the area is contained in "Archeology and Related Ethnographic Material, Kootenai National Forest, 1976".

The survey was done on a stratified basis according to probability of occurrence. High probability areas were walked and checked carefully. Medium probability areas were spot-checked on foot, while low probability areas were checked on a limited cross-section basis.

A previous survey of the area including private land was done by Dale E. Fredlund in 1975 and is included in the Stearns-Rogers Report on the ASARCO Troy Project (1975).

A survey done for the Corps of Engineers along the Kootenai River for the Libby Dam Project does not cover the Troy Project area but does provide some ethnographic information on the native people of the area and their movements. This study helps to determine the probability criteria used in studies of the project area.

In summary, none of the existing studies have found archeological sites in the area proposed for disturbance. The probability of unknown sites occurring in the area of the proposed mine adit, mill and warehouse development is very low.

Construction of the mine access road and tailings pipe line would also occur in areas of low probability for archeological sites. The probability of encountering such a site in development of the tailings pond would be medium. This is due to the distance and travel pattern of the natives. Existence of archeological sites on the shores of Bull Lake and along the Kootenai River indicate these two areas were the camp and work sites with the country between only used for travel (Johnson, 1958). In addition, the area of the proposed tailing impoundment has been extensively disturbed in the past by management of the area for timber production by the land owner.

There are no known historic sites within the area proposed to be disturbed by the mining development.

7. Recreation Facilities and Activities

Recreation facilities and activities in the Libby-Troy area are primarily outdoor oriented. Local existing urban recreation facilities include parks, play areas, and facilities for organized sports. The mountainous terrain with its associated streams, lakes, forested cover and big game animals contribute to this outdoor orientation both summer and winter.

Dispersed recreation is the primary form of recreation that takes place in the vicinity of the proposed mine-mill-tailings impoundment area. Activities included in this type of recreation include hunting, fishing, hiking, berry picking, driving for pleasure and gathering forest products. There are some undeveloped campsites in the area where people camp. There are three developed Forest Service campsites nearby, two on Bull Lake and one on Spar Lake (Figure II-7). The main activities at these campgrounds are water related; boating, swimming, water skiing and fishing. A picnic ground has been developed in conjunction with the Ross Creek cedar grove (Table II-66).

Big game and upland bird hunting are both popular in the project area. Hiking is increasingly popular in the roadless area west of the project area. Snow-mobiling is a major winter recreation activity. Cross-country skiing is beginning to increase in popularity as a winter recreation activity.

An inventory of the recreational facilities available to residents of Troy and Libby was conducted. Basically, it was determined that each city has a number of recreational facilities for their residents to use.

a. Troy

The City of Troy maintains an athletic field located adjacent to the elementary school. The field contains a track, football field, tennis courts and two baseball diamonds. There are bleachers and an announcer's booth available for football and track events. The bleachers, track and tennis courts are all in need of repair. The area also contains a shelter which is used as a concession stand, a picnic site and restroom facilities.

The city recreation areas are maintained by two park maintenance personnel who are under the direction of the city shop supervisor. The salaries of these two maintenance personnel are obtained through the Concentrated Employment Training Act (CETA) program. In addition to the CETA funds, the annual city recreation budget includes:

Supplies....................	$ 440
Vehicle Maintenance.........	140
Miscellaneous...............	800
Total.............	$1,380

At the present time, there are no funds available in the city budget for site improvements. However, a Bureau of Outdoor Recreation grant has been applied for to upgrade existing facilities and to purchase new equipment.

In addition to the recreational facilities operated and maintained by the city, there is a privately owned bowling establishment and movie theatre available to the residents of Troy.

b. Libby

The City of Libby maintains a public swimming pool and park complex. The park complex contains a baseball-football field with bleachers, a picnic area with tables and fireplaces, and a sheltered kitchen facility. These facilities are in good condition and are well maintained.

The City of Libby also maintains several parks located throughout the city, the largest being the Libby Volunteer Fire Department Memorial Park. This park has facilities for picnics and overnight camping. The remainder of the parks are primarily undeveloped.

Residents of the Libby area also have several privately owned recreation facilities for their use including a drive-in theatre, roller skating rink, miniature golf course, 9-hole golf course and a local club which has tennis courts and an indoor swimming pool.

Table II-66 Recreation Sites

Site No.	Name	Administrator	Facilities/Activities Picnic Units	Camp Units	Other*
1	Yaak River	FS	0	43	F
2	Troy KOA	KOA	0	21	T,BH,H,F
3	Savage Lake F. A. S.	FG	0	0	F
4	Dorr Skeels	FS	1	6	F,B
5	Bad Medicine	FS	4	7	F.B
6	Spar Lake	FS	0	8	B,F
7	Ross Creek Picnic Area	FS	8	0	F,H,I

* Facilities/Activities - Other -

B - boating facilities
F - fishing
H - hiking trail
I - information or interpretive exhibits
S - swimming area
T - trailer/camper hookups
W - waste disposal station

BH - bathhouse
BR - boat rental
BT - bicycle trail
FT - float trips
HS - hot springs
SS - snow sports
WS - water skiing

8. Visual Resource

The ratings for viewing significance were developed by the USFS and use two major types of criteria, scenic variety and people's concern for scenic quality. The scenic variety is determined using factors of terrain variety, geologic variety, water feature variety and vegetative patterns variety. The people's concern for scenic quality is rated using proportions of one-fourth (of those concerned) or less, one-fourth to three-fourths and three-fourths or more and is expressed as sensitivity levels. Concern does not necessarily relate to numbers of people or type of forest visitor. It relates to the concern the visitor has for the area while involved in recreation activity.

After all lands have been identified as to the sensitivity level and variety class, measurable standards or objectives for the visual management of these lands becomes important. "Visual quality objectives" have been designed to accomplish this and are represented by five terms which can be defined as visual management goals:

Preservation
Retention
Partial Retention
Modification
Maximum Modification

These objectives are keyed to the values set forth in the variety classes and sensitivity levels. Except for preservation, each describes a different degree of acceptable alteration of the natural landscape based upon the importance of esthetics. The degree of alteration is measured in terms of visual contrast with the surrounding natural landscape.

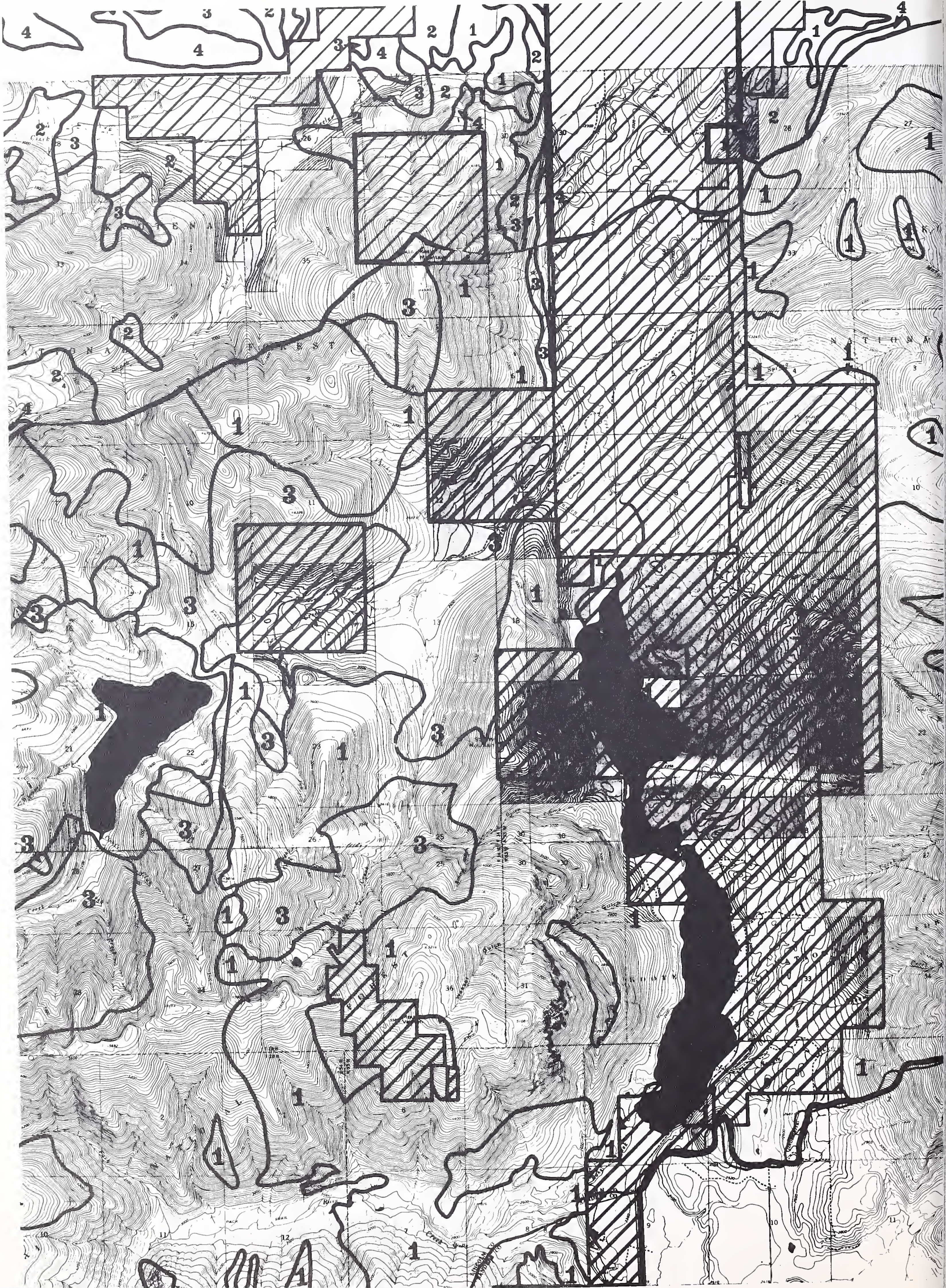
Figure II-29 contains Visual Significance Ratings assigned to the ASARCO study area according to the following table:

Viewer Position	Sensitivity Level	Scenic* Variety	Visual Significance** Foreground	Middleground	Background
Bull River Hwy.	I	A	1	1	1
Spar Lake Rd.	III	B	3	3	N.I.***
County Rd.	III	B	N.I.	3	N.I.
Bull Lake	I	A	1	N.I.	N.I.
Door Skeels Cpgd.	I	A	1	1	N.I.
Bad Medicine	I	A	1	1	N.I.

*Scenic Variety Rating: Class A - Distinctive
Class B - Common
Class C - Minimal

**Visual Significance Ratings: 1 - Very High
2 - High
3 - Moderate
4 - Low

***Seen area was Not Inventoried for indicated distance zones.


1
2
3
4
NATIONAL
FOREST

III. ENVIRONMENTAL IMPACTS OF THE PROPOSAL

A. The Physical Environment

1. Topography

The major impact of the proposed mining development upon the existing topography of the area would be the construction of a tailing impoundment on approximately 400 acres of near level terrain. The reclaimed surface of the impoundment would rise approximately ~~145~~ 100 feet above the surrounding area. The construction of the mill site would result in a change of the existing topography caused by leveling and construction of a series of small benches. The mine, mill road, utility corridor and tailing pipeline would have little or no impact upon the existing topography.

In addition to the impact of the proposed project on the area's topography, the topography would place design and location constraints upon the various facilities connected with the mining operation. The following discussion presents a site-specific analysis of the impacts of the proposed project on topography. The reader is referenced to pages 64 through 67 for a discussion of the reclaimed configuration of each facility area.

a. Mine and Associated Structures

Impact on the existing topography would result from construction of the main adit and exhaust and ventilation adits. This construction would create waste patio areas at the adit portals. The impact of the main adit portal on the existing topography would be dependent upon the final location of the main adit and amount of waste rock used for mill site and road construction.

Development of the exhaust adit would add approximately 31,000 tons of waste to the existing dump at the north portal; final configuration of this dump would be approximately 160 feet high with slopes at the natural angle of repose. Surface disturbance from the two ventilation adits would be limited to slightly more than the 15 by 20 foot cross section of the portal openings. Existing roads would be used to service the mine adits above the 3,700 foot elevation. No increase in size of the existing south adit waste dump is anticipated.

b. Mill Site

The natural topography of the area provides a series of small benches near the proposed main mine adit. These areas provide a suitable place to construct the mill facilities with minimal impact on the existing topography. The construction of the mill facilities and associated ancillary facilities, however, would require the establishment of several cut and fill benches on the side of Mt. Vernon. A tentative conception of these benches is shown in Figures I-7 and I-14. The final location and configuration of the benches is dependent upon the finalization of engineering plans and facility siting for the mill site. In general, the surface of these benches would be flat or nearly so to provide drainage. The cut and fill slopes would be approximately 1½ to 1. ASARCO has not proposed to make any extensive changes in the configuration of these benches upon completion of the mining project and subsequent reclamation.

c. Access Road

The existing road to the proposed mine and mill site would be reconstructed to a higher standard. This would result in cut banks and fill slopes higher and longer than presently exists, as well as an increased road surface width.

d. Utility Corridor

The proposed transmission line would have little or no impact on the existing topography for either construction or maintenance. Location of the line would be adjacent to existing roads and would not require the construction of extensive additional access roads. Some ground leveling for pole siting as well as construction operations would be necessary.

e. Tailing Pipeline

The proposed tailing pipeline would have no significant impact on the area's existing topography. Some ground leveling or cut slopes would be necessary to install approximately 100 drop-boxes along the upper portion of the line route.

f. Stanley Creek Well Field and Water Sump

The proposed well field and mill water sump would be located on nearly level terrain and would result in no significant impact to the existing topography.

g. Tailing Impoundment

The proposed tailing impoundment, upon completion, would occupy approximately 400 acres and rise about ~~145~~ 160 feet above the present ground level, significantly altering the existing topography (Figure II-9).

2. Climate

The proposed operation would not result in an alteration of the existing climate. The climatic conditions common to the area, however, would place design and operational constraints upon the project including:

(1) design of all mill site facilities to accommodate heavy snow loads in excess of 100 inches, heavy spring runoff volumes and periods of extremely cold or hot temperatures,

(2) road design adequate to accommodate heavy snowfall, snow removal, heavy spring runoff volumes and safe winter vehicle travel,

(3) tailing pipeline design adequate to provide protection from extremely cold temperatures and support for heavy snow loads where the line is supported above ground and

(4) provisions for adequate reclaim water supplies during periods of extremely cold weather resulting in tie-up of impoundment water in ice and periods of increased evaporation during hot summer months.

3. Air Quality

The most significant overall impact on air quality from the proposed facilities may originate not from the mine or mining operations but from the anticipated increase in population and traffic in the area. Standard predictive techniques for evaluating the effects of such growth on air quality are not well developed. However, some qualitative statements can be made regarding the impact. Total suspended particulate levels would be expected to increase for a variety of reasons, some associated with the mine and mill itself and some associated with the general population growth. Additional traffic on the mine road would result in an increased particulate emission in the valley. Some of this particulate, as previously discussed, would remain suspended and add to the total suspended particulate load in the valley. Perhaps more significant would be the effect of an increase in population in the area. The anticipated population and industrial densities are not sufficient to create a problem increase for pollutants other than total suspended particulate. The particulate problem, however, could become significant as the number of unpaved roads increases, as the traffic increases, and as the general activity associated with people increases in the area. Given the results of the limited sampling completed so far, it is not unreasonable to expect violations of the federal secondary standards in and around the town of Troy, perhaps even violations of the federal primary and state ambient air quality standards.

a. Mine and Mill Site

The actual mine site and associated structures are not expected to create any noticeable impact on air quality due to the closed and confined nature of the mining. There may be some short-term increases in total suspended particulate (TSP) arising from the early stages of mine development and other construction-type activities. These increases would be expected to be short-term in nature and confined to the immediate area of the mine.

Operations at the mill site itself would be expected to result in certain emissions of particulate matter and other pollutants to the atmosphere. The impact of these emissions would be largely restricted to the mill and immediate area. ASARCO plans to employ wet-type dust collectors on potential emission sources in the crusher building. The use of such collectors on the dust generated by the crushing operation would result in negligible emissions from the operation of the crusher itself. The addition of minor amounts of other pollutants to the air such as sulfur oxides and nitrogen oxides would result from the combustion of diesel fuel by stationary and mobile sources in the area.

b. Road and Utility Corridor

The mine road would have the most significant impact on air quality of any of the project operations. The proposed mine road would consist of an all-weather surface, provided by crushed rock from pre-mine development waste with an oil chip seal. During the construction period, however, use of the road would occur prior to it's surfacing with the seal. As with other aspects of the development itself, the impact of the mine road would in large part be restricted to that area immediately adjacent to the road. The particulate matter suspended by vehicle traffic is commonly the larger end of the particle size range and would settle out before traveling much distance in the air. A certain portion of the particulate, however, is of the finer nature and would remain suspended for considerably longer periods of time. The amount of such finer material in the dust would depend on many factors, including soil moisture, type of rock or gravel, type of vehicle and other factors.

Following completion of construction and sealing of the road surface, total particulate emissions would be expected to decrease along the access road. However, total particulate emissions including vehicle exhaust and tire wear would increase along other roads in the area, reflecting increased population and traffic.

Those impacts which are associated with the 115 Kv transmission line involve the construction of the line, and relate to ground clearing and slash disposal operations. These effects could be minimized by adherence to good air quality practices in these activities. If significant acreage is to be disturbed during the construction, it should be reseeded to reduce the contribution of dust to the air during dry seasons. The common method for slash and debris disposal from clearing operations is burning.

If burning is to be employed, a burning permit must be obtained according to established procedures, and burning done only during periods of good ventilation.

Impacts associated with the slurry pipeline and return water line are similar and relate to clearing debris disposal and excavation. These impacts could be minimized by adherence to good air quality practices. Significant acreage would be disturbed and should be reseeded to reduce windblown soil particulate. Slash and debris disposal by burning would be by permit during periods of good ventilation.

c. Tailing Impoundment

An active tailing impoundment area has very little effect on air quality. ASARCO has proposed a peripheral tailing discharge system, which, when combined with the high precipitation rate of the area should maintain a moisture content for the deposited tailing sufficient to prevent tailing dust from becoming airborne. Reclamation of the tailing impoundment dam face concurrent with it's development and reclamation of the impoundment surface following completion of the mining operation (see Chapter 1, Reclamation Plan) would further reduce the risk for tailing related dust.

4. Geology

With the exception of the physical removal of a portion of a stratabound mineral occurrence, resulting in a reduction of identified mineral resources, the proposed project would have no direct impact upon the geology of the area. The geology, however, must be considered to have limiting influence on the proposed project in terms of location and facility design. The location of the ore body, for example, because of economic constraints, mandates the nearby location of the milling and processing facilities. In addition, the geologic characteristics of the ore body determine the mining methods used to extract the ore.

Several inactive faults have been identified as occurring between the proposed Mill site and tailing impoundment (Figure III-1). If these faults were to become active during the life of the project, the potential for significant adverse impacts to the existing environment caused by pipeline breakage, or tailing impoundment failure would be great.

5. Soils

The potential impacts to soils from the proposed project have been identified as (1) direct soil disturbance and soil compaction during leveling, grading and construction activities, (2) soil erosion from areas disturbed during construction activities and areas not revegetated during the

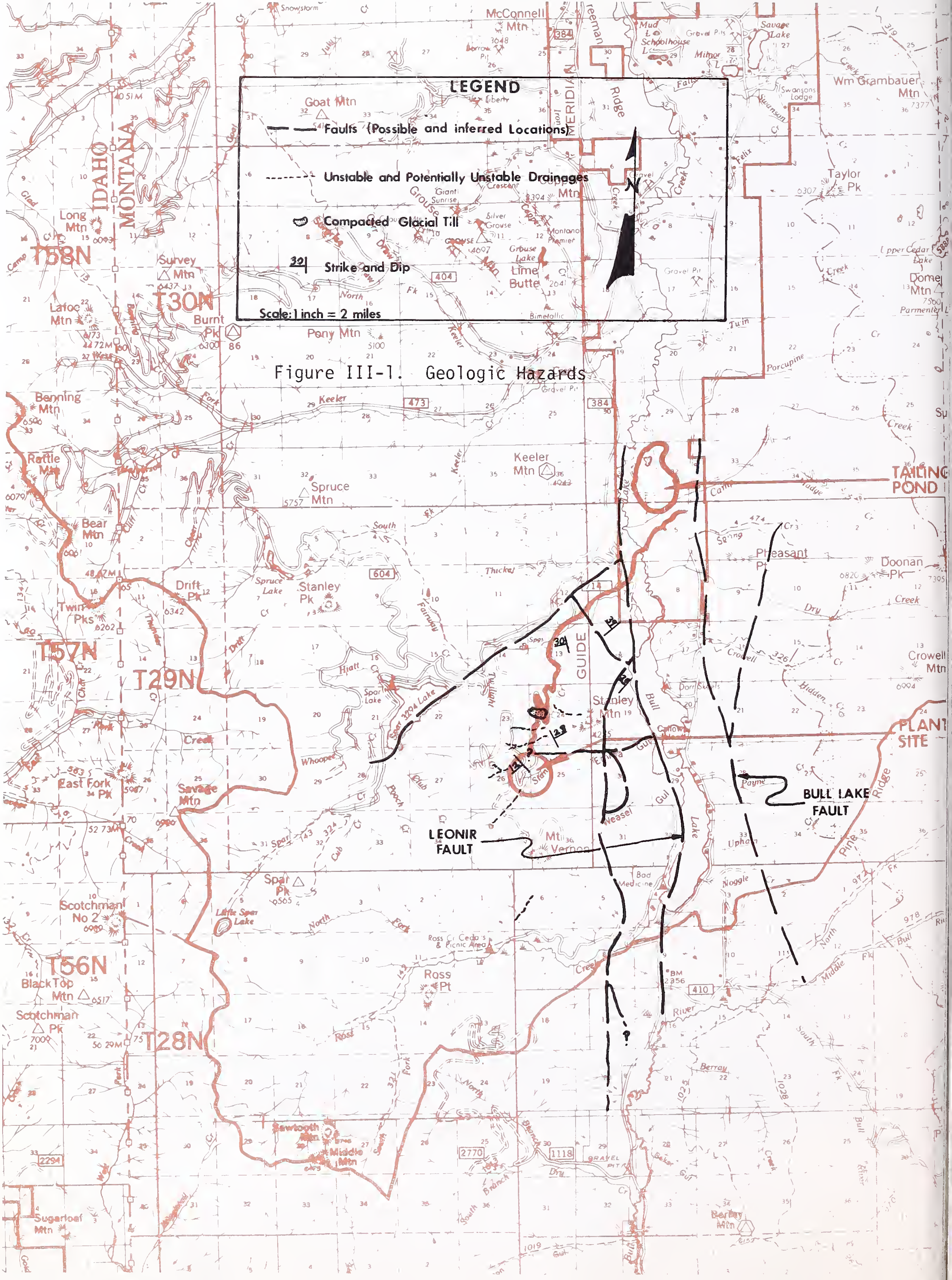


Figure III-1. Geologic Hazards

project life and (3) mass soil movement initiated by construction activities on areas with unstable soils.

a. Mine Site

The proposed main adit portal, and exhaust and ventilation adit portals would result in the covering of native soils with waste rock material. These soils would be permanently removed from their former productive capacity.

The proposed mine adit and patio is located in a soil type that has deep glacial alluvial soils. Depth of these soils has a limiting influence on the final location of the main adit. The adit must be located where bedrock is relatively close to the surface to prevent unstable conditions in unconsolidated material.

b. Mill Site

The mill is located on an area of deep glacial alluvial soils with the depth to bedrock approximately 50 feet. Impacts to the soils during the construction of the mill site facilities would primarily involve a redistribution and mixing of the existing soils. Topsoil is not proposed to be salvaged from the mill site. Leveling the mill site, if it were to involve cut slopes in excess of 10 to 12 feet would cause slumping and erosion of the soil. The soils on the proposed mill site are capable of supporting the mill facilities. Excessive runoff from leveled and surfaced areas around the mill site that is uncontrolled would cause erosion, channeling and slumps in the steep slope below the mill site.

c. Mine Road

The impact to soils resulting from the mine access road would primarily involve a redistribution and mixing of existing soils caused by longer and higher cut and fill slopes involved in the proposed upgrading of the existing road. This would increase the potential for erosion and sediment transport until revegetation occurs.

d. Transmission Line

Construction and maintenance of the proposed transmission line would result in a redistribution and mixing of existing soils at pole sites and other sites requiring leveling activities. Erosion of soils is the most serious problem which may be caused by equipment involved in site preparation and pole erection. Movement to and from construction sites by the equipment may lead to breakdown and damage to existing and new access roads, resulting in erosion on areas of steep slope and erodible soils. This condition may be compounded by road use during wet conditions, as ruts generated by travel in steep areas provide effective means for the channeling and rapid transport of inorganic material.

Road construction required for access to and maintenance of the proposed transmission line would be minimal, as the route of the proposed line generally parallels an existing road. If not properly constructed, roads can ultimately result in the direct disturbance, through erosion and sedimentation of a much larger area than is involved in the transmission line right-of-way. Steep mountainous areas with erodible soils are susceptible to soil mass movement and landslide erosion. Roads through such areas often provide the triggering mechanism for mass movements.

Pole site preparation areas and cleared areas, necessary for maneuvering construction equipment, reduce plant cover and may increase erosion potential. The removal of vegetation, particularly from steep slopes or near stream channels along the right-of-way, may lead to increased soil erosion.

e. Tailing Pipeline

Impacts to the area's soil resulting from the proposed tailing pipeline would be similar to those identified for the transmission line.

f. Tailing Impoundment

Construction of the tailing impoundment and adjacent facilities would involve the removal of approximately 1 million cubic yards of topsoil from soil mapping Unit 1 as identified in Figure II-2. Topsoil would be stockpiled in several locations for future use in reclamation activities (Figure I-18). Reclamation during and following the project would involve redistributing the topsoil at several facilities, including the mill sites. In addition to the topsoil removal and storage, disturbance resulting from the impoundment construction and other related activities would potentially mix or disrupt the native soils over an area of approximately 1000 acres. Removal of vegetation would significantly increase the potential for erosion and sediment transport. The area as been extensively disturbed in the past through timber harvesting activities.

Within the approximately 400 acre impoundment site, leveling and grading activities would disrupt the soils and result in substantial mixing of the soil layers. These soils, however, would eventually be buried by accumulated tailing and become compacted by it's weight. In addition, these soils could be altered as a result of an ion exchange with the infiltrating tailing seepage. This would result in the permanent loss of the productive capacity of these soils.

6. Water Resources

Analysis has shown that the normal operation of the proposed facilities would not result in a significant adverse impact to the areas existing subsurface and surface water resources. The major potentials for impact to the existing water resources of the area as a result of the proposed project would include (1) an increase in stream sedimentation during the construction phase of each facility and (2) a failure of the proposed systems resulting in the spillage of toxic chemicals or tailings along waterways. A significant impact to water quality could occur if the tailing pipeline were to fail and tailings enter Stanley Creek or Lake Creek. Such a failure would introduce tailing sediment into the streams, increase turbidity and create tailings deposits on the stream bottom, thus causing both acute and chronic affects on the aquatic life, and a direct short-term minor impact on water chemistry. Failure of collapse of the tailing pond would introduce vast amounts of tailing sediment into Lake Creek and seriously degrade the existing water quality.

The following site-specific analysis presents information related to the operating phase of the proposed project. While a specific discussion of the potential water quality impacts related to the construction phase of each facility is not presented, it can be assumed that there would be an increased potential for the addition of sediment and oil and grease related to the intensity of construction activities and their proximity to surface water sources.

a. Mine Site and Associated Structures

The mine site would consist of a large waste rock patio near the mine, a portal and access roads. Four potential sites for the mine portal have been proposed (Figure I-13). It is expected that water would be encountered during underground mining and would vary in flow from a few tens of gallons per minute to possibly as much as 2500 gallons per minute. It is proposed that during the first 1 to 1½ years of the project, during the mine development, mine waters would be disposed by infiltration into the waste rock dump where it would enter the groundwater system and eventually flow into upper Stanley Creek. The phrase "Upper Stanley Creek" refers to the perennial stream segment in the uppermost portion of the stream system (see Hydrology Section, Chapter II for detailed description). This method presently is used to dispose of water exiting at the existing north adit. The base flow of upper Stanley Creek is estimated to be 1 to 3 cfs with much higher flows during the spring runoff period. Discharge of waters to Stanley Creek would be regulated by Montana Water Pollution Control Act (69-4801 etc. seq.) (Montana Water Quality Standards) MAC 16-2.14 (10)-S14480 and the MPDES rule (Montana Pollutant Discharge Elimination System) MAC 16-2.14(1)-S14460. It is anticipated that flow from the adit would increase the flow of upper Stanley Creek; however, it is probable that the existing stream flow would be larger than the adit flow, thus the addition of the adit flow would not cause a major increase in flows in upper Stanley Creek. The proposed ASARCO MPDES discharge assumes a maximum adit discharge of 2500 gpm (5.57 cfs). A flow of this magnitude would significantly increase the flow of upper Stanley Creek, but since the stream naturally flows much larger during spring runoff, no significant adverse impacts should result from an increase of 5.57 cfs. Although an adit flow of this magnitude is not anticipated, if encountered and added to upper Stanley Creek, some increased erosion effects could occur during high flow periods in upper

Stanley Creek.

Prior to exiting the mine, adit waters would be treated by settling inside the adit (see Page 61). From the two underground sumps, water would be piped to a small holding sump outside the portal, and then to the mill water reservoir for discharge (see Page 45).

The large sediment settling planned by ASARCO should reduce suspended sediment to acceptable levels. Water from the in-mine settling facility would infiltrate into broken waste rock at the main adit portal. This should remove much of the remaining oil and grease and suspended solids.

Another potential water quality impact would be from dissolved materials in the adit effluent. Water quality testing during this investigation has shown low concentrations of metals and generally good water quality (see Water Quality Section, Chapter II).

Equipment operation and blasting inside the mine would cause oil and grease sediment and nutrient input to the adit water. As previously described, oil and grease and sediment would be removed. Nitrogen from blasting would enter the water and increase the nitrogen content. The amount of increase is unknown and would depend on adit water flow, efficiency of blasting and care in handling explosives. The nitrogen concentration estimated by ASARCO in their MPDES permit application is 15 to 20 mg/1. If large adit flows were encountered, nitrogen concentrations would be reduced by dilution.

It is clear that substantial nitrogen enrichment would be probable in upper Stanley Creek. This also would cause some increase in nitrogen in Stanley and Lake Creeks. Impacts of this nutrient increase are discussed in the Aquatic Fauna Section, Chapter III.

Present quality of water from the north adit (described in the Water Quality Section) is good. Parameters of concern in this effluent that have been addressed are pH, metals, hardness and alkalinity. All existing data show water from the north adit to be neutral or slightly basic and hardness and alkalinity are higher than in Stanley Creek. Metal concentrations reported by have wide variations some of which are thought to be analytical or sampling errors. All metals sampled during this investigation have low concentrations and no significant chemical impacts from metals are expected. Dilution of adit effluent in Stanley Creek and Lake Creek will be large, thus, no adverse chemical impacts are predicted in the Lake Creek system. This impact analysis assumes quality of future flows will be very similar to existing effluents.

There are other concerns relative to encountering additional water in the mining operation including the possibility of toxic waters or generation of acid mine water. In any underground operation mining sulfide ores, there is a potential for generation of acid by the reaction of air (oxygen), water and sulfide-bearing materials, particularly pyrite. This is a common reaction that occurs in many mines in many areas. By far the best indicator of the possibility of generating acid mine water is the existing quality of water from the adits. Presently there appears to be no tendency to generate acid mine water or the acidity that is generated is substantially less than the alkalinity generated by the mine rock/water reaction (B. C. Research 1976). There is no indication that further development of this mine will encounter acid mine waters, and there is no predictive technique available to determine if this will occur. The drainage from the existing adits has occurred for several years and to date and no acid drainage has been produced.

Another question that must be addressed is the possibility of encountering a body of toxic water in the mine. The reaction and dissolution of some minerals by water can yield waters that are toxic and could possibly be contained in a hydraulically isolated block. The general geology of the area indicates that rock fractures are the dominant paths for water transport and the rock type is consistent throughout the area. An independent body of water with a poor or no hydraulic connection to the remainder of the rock system would be an unusual system. Encountering a body of water in a mine having a substantially different quality than water in the remainder of the mine also is unusual. There is no evidence to suggest that a body or bodies of toxic water exist in this mine. Although the probability of the occurrence of a body of toxic water cannot be assumed to be zero, the probability of this occurrence seems to be remote and should be considered a very unlikely problem.

Another potential water quality impact could be from runoff from the waste rock at the mine waste rock patio. Erosion of the waste rock could cause transport of sediments to the nearby stream channel. This patio, however, would have a relatively small surface area and very little or no runoff should occur. Additionally, the coarse material in the waste dump will allow infiltration into the subsurface, thus, no impact on water quantity is expected from the waste rock patio.

b. Mill Site

The milling facilities would consist of a crusher, ore storage, an ore concentrator, shop and warehouse, tailings thickener, offices and parking area (Figure I-7). Milled rock waste from the concentrator would be transferred by an 18-inch diameter transite pipeline to the tailings thickener. Some water from the tailings thickener overflow would be returned to the mill for reuse and the slurry underflow would exit the thickener and be transported by pipeline to the tailings impoundment approximately 6½ miles distant. There are no discharges proposed to natural surface waters from any of the mill facilities, therefore, there will be no impact on surface water quantity or quality resulting from operation of the facilities.

Runoff water from natural drainages was addressed in the operating plan (ASARCO 1976):

> *Water from the major water courses, during periods of runoff and heavy rain, will be captured at the plant site and escorted through or around, the plant and returned to its natural drainage course.*

In this area, the natural drainage course is the South Fork of Stanley Creek. In later plans, ASARCO (February 1978) stated that the exact location of surface diversions are unknown, but that:

> *ASARCO is committed to adequately control drainage, protect slope stability, prevent erosion, water pollution and reclaim disturbed land under a state approved plan.*

Surfacing in the plant area would primarily be a oiled, rock-chipped surface. It is anticipated that there would be no impact on water quality from this facility. Natural drainages tributary to Stanley Creek at their diversion around or through the plant may have some changes in their gradients and may cause some minor erosion and sedimentation in the main stream. Water quality problems associated with this water diversion will be a function of the final design and installation of diversion facilities. It is anticipated that this would be a very minor water quality problem.

A potentially significant problem would be the pipelines that extend from the mill site to the tailing thickener and return to the mill site. A significant impact to water quality could occur if these pipelines were to fail and tailings enter Stanley Creek. Such a break could have both acute and chronic affects on the aquatic life in Stanley Creek and would have a direct short-term impact on water quality.

Although such a failure of the tailings line system could have serious impacts, the possibility of such an event is low. Because of the length of the tailings line from the mill to the thickener, it would probably be the most vulnerable point in the milling operation. Design, construction and operation of the proposed tailings line all have an important bearing on the overall environmental safety of this line. It is anticipated that with careful design construction, installation and operation, this system would be relatively safe. In the unlikely event of a failure of the tailings line at any point between the mill and tailings thickener, tailings would be deposited on the hillsite, a portion of which could flow down the hillside into nearby Stanley Creek and be transported in Stanley Creek some distance downstream. The impact on Stanley Creek would be a function of flow in Stanley Creek and the volume of Tailings lost in the line. During the time of the year that Stanley Creek has a dry segment between upper Stanley Creek and its confluence with Fairway Creek, the tailings impacts would be confined to the upper portion of Stanley Creek. During the runoff season, however, tailings would be transported down Stanley Creek into the lower portion of Stanley Creek and into the Lake Creek drainage.

Based on a proposed pipeline length of 2500 feet and a diameter of 16 inches, the tailings transport line would contain approximately 20-30 tons of tailings. The line would be within a few hundred feet of Stanley Creek along a relatively steep hillside. If a spill occurred, a substantial portion of the unthickened tailing would probably flow downslope.

The water quality impact of a pipeline failure between the mill and the concentrator thickener cannot be predicted with accuracy; however, it seems probable some tailing could enter Stanley Creek, thus increasing the concentration of sediment metals in the stream.

The great variability in spill conditions including tonnage spilled, retention on the slope, area of the spill, stream stage, ice conditions, rate of release of tailings material and a number of other variables, as well as alternative locations for tailings thickeners make it impossible to quantify potential water quality impacts of a spill from the mill-concentrator pipeline. Tailing sediment in Stanley Creek would increase turbidity, create tailings deposits on the stream bottom and impact aquatic organisms (see Aquatic Fauna Section, Chapter III). Based on the anticipated chemistry of the tailings (see Water Quality Section, Chapter III) direct impacts on water chemistry would be minor.

Milling facilities and tailings thickeners have been used in numerous operations in many areas of the United States and failures of these structures are very uncommon. Discussions with mining and water quality officials in Colorado, Idaho and Montana revealed no known failures of these facilities. There should be no water quality impacts from these structures during the operation's life.

c. Tailing Pipeline

The integrity of the tailings and return pipelines is a concern in view of the fact that a line failure may cause water and/or tailings to enter Stanley or Lake Creeks. Within the proposed pipe corridor, the areas of most concern are the segments near streams particularly on steep slopes. The areas of concern are near the tailings thickener, at two segments downstream from the fresh water wells and along Lake Creek. In the event of a failure of either the gravity slurry line or the return line or both lines, there would be a loss of water into the watershed and a water quality problem could occur. The major impacts of such a spill would be increases in turbidity and suspended sediment in Lake or Stanley Creeks. Based on anticipated tailings quality (see Page 312) there would not be a problem of dissolved minerals or metals.

To monitor the system, it is proposed to use flow sensors which would respond to breaks or blockages in the tailings line (see Page 46). It is anticipated that this system would signal interruptions in tailings flow, indicating broken or plugged sections of the pipeline. Since design of the system is not finalized, the quantitative reduction in a tailings spill cannot be predicted; however, the system would limit the tailings loss from a line failure.

Approximately 2,900,000 tons of tailings will be disposed of annually in the tailings pond. At any one time the tailings pipeline and dropboxes would contain approximately 180,000 gallons of slurry and about 450 tons of sediment. In the event of failure of the pipeline, slurry from the pipeline would be deposited on the ground and could eventually enter Stanley Creek or Lake Creek. Based on the chemical quality anticipated in the tailings, it is concluded that toxic concentrations of metals probably would not be reached in either the Stanley or Lake Creek systems; however, a problem could occur from suspended sediment and turbidity.

Line failure could basically occur as a leak or break in the line or a plugging of a drop box or boxes. There are several alternate locations for the upper part of the tailings line (Figure I-17) but the line initially follows a steep grade and then traverses a more gentle slope to the tailings pond. The proposed line route is very near Stanley Creek at some points and distant at others. It is difficult or impossible to predict the actual impact of a line failure. It would be highly dependent upon location of the line failure, the amount of tonnage involved in the failure, the time of year, vegetation and snow cover, distance to the stream and a number of other variables. In areas of gentle slope, and at significant distances to streams, much of the tailings would be deposited on the hillslopes. Conversely, steep slopes near streams would be areas of maximum potential impact from spills.

Based on 450 tons of solids (maximum content of tailings line) and assuming half reached Lake Creek (an arbitrary assumption), which was flowing 50 cfs, in a time period of two hours, a suspended sediment concentration of 20,000 mg/1 could be reached. A larger stream flow, or a shorter time of addition of sediment, would increase this concentration. Conversely, a long time period or a smaller spill, would decrease the concentration. A suspended sediment concentration of 20,000 mg/1 is a very high concentration and would create problems in the aquatic system as described in the Aquatic Fauna Section, Chapter III. A similar analysis can be made for Stanley Creek. Stanley Creek as it approaches Bull Lake has a low gradient and would be significantly effected by tailings. The impact would primarily be sediment deposition and a change in the stream and lake substrata. A spill of tailings into Stanley Creek would ultimately result in deposition in the northern most end of Bull Lake. No toxic chemical impacts would be expected due to the chemical characteristics of the tailings and the dilution capacity of Stanley and Lake Creeks. The impact of sediment on streams and Bull Lake is discussed in the Aquatic Fauna Section, Chapter III.

d. Tailings Impoundment

(1) Seepage

The proposed tailings pond eventually would have impacts on groundwater, surface water and water quality. The most significant potential impact of the proposed tailings pond would be infiltration of tailings pond water into the subsurface and subsequent percolation of this water to Lake Creek. Of concern would be the potential quantity and quality of seepage water exiting the pond and entering Lake Creek.

Several statements have been made relative to potential seepage of water from the proposed pond. The report by ASARCO (1976 Page 24) states: "The quantity of water lost to seepage is very difficult to estimate".

In this report it was estimated that seepage would be 292 to 803 gallons per minute.

The report by WADEVCO (1976 Page 9-2) states: "The estimated range of permeability of the material is from 1 X 10^{-7} to 1 X 10^{-6} cm/second. For the initial 265 acres of pond area this translates into a continuous downward flow of 17 to 170 gpm . . ."

The Woodward-Clyde report (January 1977 Page 8) states: "We believe seepage losses out of the tailings disposal area will be moderate and will depend on the distribution of the more previous sands and gravels beneath the area and the permeability characteristics of the tailings fine".

Data obtained from the tailing impoundment area by Woodward-Clyde (January 1977) contains 25 permeability measurements in 11 test holes. The data showed a wide range of permeability.

This report also stated that the actual permeabilities may vary from the calculated permeabilities and that gravelly soils found in the southeast corner of the site could be continuous and provide movement in a southerly direction.

Tailings placed in the pond would probably significantly alter the pond seepage rate. Information from other tailings ponds suggest that tailings would "seal" permeable zones. Tailings typically have permeabilities ranging from 10^{-3} to 10^{-7} cm/second and can exert important influences on seepage (Williams, Kealy and Daniels 1974). This report also showed pond seepage can be minimized by a carefully designed and managed peripheral tailings discharge system.

A rough estimate of pond seepage can be made using a modification of the Darcy equation:

$$Q = AK \frac{dh}{dl}$$

where Q is groundwater flow, A is area through which groundwater moves, dh/dl is the groundwater gradient and K is permeability. Using the average permeability determined from tests in the pond area of 800 ft/yr; a gradient from the tailings pond center at its maximum height above the water surface in Lake Creek; and assuming water movement through the entire earth section the height of the natural terrace along Lake Creek, a seepage of approximately 510 gpm is calculated.

In view of the range in permeability listed for the ponds and the presence of some permeable gravels, it should be assumed that seepage from the pond would vary with time and would vary in response to the technique used for tailings disposal. If pond water with low concentrations of suspended sediment were to encounter permeable gravels, it should be assumed that the entire flow to the tailings pond could percolate into the subsurface.

Based on the ASARCO (1976 Page 23-24) analysis, the proposed maximum flow to the tailings pond would be 1461 gpm and an estimated equivalent of 292 gpm would be bound in the tailing, thus, potential maximum pond seepage would be 1169 gpm (1170 gpm used in this report).

It is possible to develop a computer analysis utilizing a finite element model to estimate seepage from the pond as shown by Kealy, Daniel and Busch (1971) and Kealy and others (1974). Utilization of a finite element model, however, is time consuming and expensive, and the increased accuracy in the seepage estimate is not a sensitive variable in this impact assessment. The assumption of a seepage of 1170 gpm is a worst case analysis using the maximum seepage rate.

Seepage from the tailings pond would add to as much as 2.6 cfs (1170 gpm) to the groundwater system and to flows in Lake Creek. Addition of this amount to the existing groundwater system would have little impact as there are no wells or springs used downgradient from the pond. Subsequent seepage into Lake Creek also should have little impact on water quantities as it would add only a small amount to the flow in Lake Creek. Appendix T contains comments provided by the U. S. Bureau of Mines related to construction and permeability of the proposed tailing dam and pond.

e. Water Quality

Water quality in the tailings pond would be determined by natural water input into the mineral processing system, rock/water interaction in the system, particularly from the milling process, additives to the water and any chemical alterations brought about by interactions within the pond.

The flotation/separation process to be used in the milling operation was tested using a bulk sample from the mine and water from Stanley Creek. It is anticipated that the quality of this water will be representative of water sent to the tailings ponds. As reported by WADEVCO (2976 Page 7-5) results of these tests are contained in Table III-1.

Table III-1 Anticipated Quality of Tailing Water (WADEVCO 1976)

	Mg/1			Mg/1	
Constituent	Sample 1	Sample 2	Constituent	Sample 1	Sample 2
Silver		0.02	Barium	1.0	.30
Arsenic		.004	Calcium	16.5	16
Cadmium	0.001	.003	Potassium	13.5	18
Chromium	.002	.02	Magnesium	3.0	2.9
Copper	.045	.22	Sodium	19	3.6
Iron	.15	1.3	Carbonate		0
Mercury	.001	.0005	Bicarbonate		73.2
Manganese	.305	.17	Chloride		4.9
Molybdenum	.056	.03	Fluoride	.2	.2
Lead	.010	.12	Nitrate		1.9
Antimony	.01	.03	Phosphorous	.21	.10
Selenium		.01	Sulfate	98	15.4
Tin		.08	Cobalt	.003	
Tellurium		.05	Nickel	.001	
Titanium	1	.02	Dissolved Solids	131	123
Zinc	.030	.10	Suspended Solids		19.2
Aluminum	.130	.30	pH		6.8

This report also notes that there was no gamma or beta plus alpha radiation recorded from the samples.

With the exception of metals, the expected tailings water quality is good. Silver, copper, manganese, molybdenum, zinc and aluminum all exceed mandatory or recommended water quality criteria. The tailings pond water quality would be modified, however, by a number of processes including oxidation in the pond, percolation through tailings and percolation through the underlying silts and clays. These fine-grained materials beneath the pond would cause some sorption and ion exchange of metals. Metals removal by earth materials has been examined in a number of waste systems and generally fine-grained materials have significant capacity to remove metals.

A soil sample from the proposed pond area contained 30.4 percent sand, 50.4 percent silt and 19.2 percent clay. The CEC (cation-exchange capacity) was 0.277 millequivalents per gram (MTL 1978). The high clay content and CEC suggests there could be significant adsorption of metals beneath the pond. As described by Haung, Elliott and Ashmead (1977) soils, particularly clayey soils, can be very effective in removing metals from percolating waters.

Based on the quality of water anticipated in the tailing pond (Table III-2) and assuming no dissolution of metal from the tailings and no sorption of metals on materials beneath the tailings pond, and an assumed seepage of 1170 gpm, a worst case analysis of the impact on water quality in Lake Creek can be estimated. For purposes of calculation, it would assume that the flow in Lake Creek would be 50 cfs, which is approximately the least flow that has been measured in Lake Creek near the proposed tailings pond since October 1973. This includes two years of very low flow in the Lake Creek system. There are insufficient data to calculate the 7-day, 10-year low flow, however, it is expected that the 7-day, 10-year low flow would be approximately 50 cfs. At this low streamflow, the impact of pond seepage water on Lake Creek would be maximum. Utilizing these assumed pond seepages and an assumed flow in Lake Creek of 50 cfs, the approximate dilutions for constituents entering Lake Creek would be about 20:1 (this is the dilution ratio of water in Lake Creek (50 cfs) and pond seepage (1170 gpm)). Constituents in the proposed tailings pond decant water that exceed the applicable criteria outlined by Botz and Peterson (1976) are listed in Table III-2. With this dilution, the concentration of constituents that could potentially enter Lake Creek when Lake Creek is at a very low flow and with the tailings pond seeping 1170 gpm, are well below the applicable criteria. Metal reactions in soil/water have been examined by numerous investigators, including Haung, Elliott and Ashmead (1977). These reactions can be of significant importance and can lead to substantial metal removals by sorption. It is anticipated that concentrations of metals in water seeping from the pond will be significantly reduced due to soil/water interactions (see Water Quality Section, Chapter III).

Table III-2 Constituents in the Proposed Tailing Pond that exceed Applicable Criteria

Constituent	Concentration in seepage* (mg/1)	Concentration after 20:1 dilution (mg/1)	Applicable criteria** (mg/1)
Silver	0.02	.001	.003
Cadmium	0.003	.00015	.0004
Copper	0.22	.011	.02
Iron	1.3	.065	.20
Manganese	0.305	.015	.05
Molybdenum	0.056	.003	.01
Lead	0.12	.006	.05
Zinc	0.10	.005	.01
Aluminum	0.30	.015	.05

*Maximum values taken from the two analyses of anticipated tailings pond water (WADEVCO 1976).

**Taken from Botz and Peterson (1976). Represents lowest concentration that has been shown to have adverse impacts; or maximum recommended concentrations for public water supply, livestock, long-term irrigation and maintenance of freshwater aquatic life.

Milling reagents added as a result of ore concentration (Chapter I). Would be contained in the tailing impoundment. The reagents and concentration in tailing water are estimated to be as follows:

Reagents	Composition	Quantity in Water
Dowfroth 250	Glycol methyl ether	5 ppm
Pineoil	Terpineol	5 ppm
Xanthate	Potassium amyl xanthate	5 ppm
Sodium hydrosulfide	NAHS	400 ppm

A determination of residual flotation reagents remaining in the tailings water was made by ASARCO (Henderson 1976). Results of this test showed that the following residual quantities were present:

Dowfroth 250	1.5 ppm
Xanthate	2 ppm
Pineoil	0.1 ppm

The measured quantities of reagents in a test, thus, were substantially less than the amounts originally estimated by ASARCO. Potential impacts of these additives were discussed in a communication by Parrish (1976):

> *Terpineoil and glycomethyl ether are both used as frothing agents. Terpineoil (otherwise known as pine oil, alpha-terpineol, or cyclic terpine alcohol) appears to be relatively nontoxic. Test with bluegills indicated a 48 hour* TL_m *of 69 ppm (all test results reported are not final and indicate relative toxicities only).*
>
> *The material tested was produced by the Hercules Company under the trade names "Yarmor F and Yarmor 350 (although the chemical tested may be nontoxic it may be similar to phenol in tainting properties).*
>
> *Glycomethyl ether was listed as polypropylene glycolmethyl ethers manufactured by Dow Company as Dowfroth. The Cyanamid Company may manufacture a similar compound under the trade name Aerofroth. The toxicity of Dowfroth to bluegills was greater than 1000 ppm v/v (or relatively nontoxic). Some Aerofroth compounds were moderately toxic with the lowest concentrations ranging from 10-100 ppm v/v for Aerofroth 77. The Water Quality Criteria (Bluebook) lists quaiacol (another name for glycomethyl ether) as a flavor producing agent with 0.1 ppm as the highest concentration that does not impair flavor.*
>
> *Potassium amyl xanthate is a collector which is completely water soluble and relatively stable. Commercial products based on potassium amyl xanthate were listed as Z-6 (Dow Company), Aero Xanthate 350 (Cyanamid Company) and CX-51 (Chemcell Company). Toxicities reported ranged from 0.1 to 1.0 ppm w/v for Daphnia magna to 18 to 180 ppm w/v Potassium promelas.*

The 48 hour TL_m refers to the median tolerance limit for a 48 hour test. This is the concentration that would cause mortality of 50 percent of the test organisms in 48 hours. Warm water fish such as bluegills generally are less sensitive to pollutants than are salmonoids.

The reactions of organic reagents during ponding in the tailing pond and during infiltration through tailings and earth materials are unknown. These reagents may decompose in the tailings pond, as do many other organics, or they could be sorbed or altered in composition (from complexes precipitates, etc.) during percolations beneath the pond.

Based on the expected and measured concentrations of these reagents, their relative toxicity and dilution in the hudrologic system - no impacts are expected from milling reagents.

(2) Structure Failure

Failure of the tailings pond would have serious to catastrophic water quality impacts. The probability of such a failure is very low and the mode of failure would be important, i. e., a slow versus rapid failure. A rapid and large failure of the tailings impoundment dam could lead to severe suspended sediment problems in both Lake Creek and the Kootenai River. The impact of such a failure probably would not cause a toxic chemical condition, but would be a major problem in the physical effects of suspended sediment and turbidity on aquatic organisms (see Aquatic Fauna Section, Chapter III). Since dam failure is a remote possibility and the mode of failure so speculative, a detailed assessment of this potential impact is difficult.

Failure of modern large tailings impoundments are virtually unknown. Design, construction and operation of tailings pond has improved substantially and there has been a corresponding reduction in failures. There is no method to accurately assess the probability of failure of the proposed ASARCO tailing impoundment. The possibility of such a failure, however, appears very remote. If failure were to occur or become eminent, it is likely that there would be adequate time available for remedial or preventive actions.

Appendix T contains comments on the proposed tailing dam and pond construction as provided by the U. S. Bureau of Mines, Western Field Operation Center, Spokane, Washington.

(3) Channel Migration

Long-term channel migration and slope retreat is the geological mechanism forming the Lake Creek valley. This process undoubtedly is continuing and eventually, without correction, could cause long-term stability problems at the proposed tailings dam site. Mitigation of this potential impact is described in Chapter IV.

f. Stanley Creek Well Field

It is anticipated that fresh makeup water supply for the concentrator would be supplied by a well field from an area in the vicinity of the confluence of Stanley and Fairway Creek. The purpose of the well field is to develop approximately 2,500 acre-feet of water per year.

A seismic refraction survey of the proposed well location area was conducted by Dames and Moore (1974). The survey indicated a large aquifer present ± 30 feet below the surface in the area. This site may be capable of supplying the required 2,500 acre-feet of water per year. Groundwater obtained from wells in this area would surely be in hudraulic connection with surface water in Fairway and Stanley Creeks. The water requirement of approximately 2,500 acre-feet per year (about 3.8 cfs) is substantially less than the flow of the Fairway/Stanley Creek system at this point and although it is expected that there may be some reduction in the surface flow of the stream system, no significant reduction in flow should occur. There should be no impact on water quality due to the proposed well field.

B. The Biological Environment

1. Flora

The major impact to the vegetation of the area as a result of the proposed project would be the direct removal of vegetation during the construction of various project facilities. The Stanley and Lake Creek areas have high potential for wood production and are generally well suited to intensive forest management. Nearly all of the proposed facility construction would occur in the highly productive cedar and hemlock climax areas, as well as areas of vegetation important to wildlife. Removal of vegetation and it's loss of productive capacity would not be permanent at any of the proposed facility sites with the possible exception of the main access road. Reclamation, if successful would return those areas disturbed during the life of the project to a productive capacity.

a. Mine Site and Associated Structures

Construction of the main adit portal, ventilation adits and mine waste patios would remove approximately three acres from production for the life of the project. It is estimated that about 54,000 board feet of marketable timber is present on these sites with an approximate value at present of $2685. There would be no permanent loss of potential timber production if reclamation is successful.

b. Mill Site

Construction of the mill site would remove approximately 20 acres from a productive capacity for the life of the project. It is estimated that about 360,000 board feet of marketable timber is present on this site with an approximate value at present of $17,906. A certain amount of revegetation would occur during the life of the project on cut slopes and fill banks. There would be no permanent loss of potential timber production if reclamation is successful.

c. Utility Corridor and Mine Road

The transmission line, tailing pipeline and reclaim water line would be located within a 300 foot corridor paralleling the main access road. Within this corridor, an as yet unknown area of vegetation would have to be removed to allow installation, operation and maintenance of these facilities.

The width of the right-of-way for the new portion of the proposed transmission line could be considered lost to the productive base as trees would not be allowed to grow under the line during the life of the project. The right-of-way width for the proposed line would vary depending on the type of pole structure present; the normal single pole structure as proposed by Northern Lights Inc. would require 30 to 25 feet of right-of-way clearance, while situations requiring a double pole structure would require a minimum of 50 feet of clearance. A right-of-way of 35 feet for the 7.4 miles of new construction proposed would result in a loss to the commercial productive base of about 31.4 acres. Following completion of the project, as removal of the transmission line if other uses are not found, these lands would return to their productive base.

Rebuilding of the existing line is not expected to result in any significant impact to vegetation if the right-of-way is not significantly widened.

Accelerated erosion would occur on scarified areas, particularly if purposeful revegetation is not practiced. Revegetation of the right-of-way is not expected to pose any problems due to the 40 inches or more of precipitation the area receives.

Commercial timber removed during the right-of-way clearance could be sold and processed locally. The amount of logging slash resulting from the clearance would not be expected to present a significant disposal problem.

In addition to loss of vegetation through upgrading the existing access road, increased dust generated along the road during construction activities would probably have an adverse affect on the adjacent vegetation. Once the road is completed and an oil seal chip surface applied, dust would no longer be present in significant quantities. New road construction adjacent to the tailing impoundment area would remove an unknown amount of vegetation from approximately one mile of road route. Impact to adjacent vegetation along this section of road would be similar to that along the remainder of the road proposed for upgrading.

Vegetation impacts resulting from the proposed tailing pipeline would be similar to those identified for the transmission line. Burial of the reclaim water pipeline would require the removal of vegetation along the route selected. Following completion of the mining project, the tailing pipeline would be removed and the disturbed area would return to it's productive capacity.

A breakage or malfunction of the proposed tailing pipeline resulting in the spillage of tailing would directly affect the adjacent vegetation by burial or alteration of the existing substrate. If the spills were cleaned up and the surface affected prepared for suitable vegetation substrate, the loss of the vegetation would not be long-term.

d. Tailing Impoundment

The construction of the tailing impoundment and deposition of tailing would directly remove from a productive capacity approximately 400 acres of highly productive timber lands. In addition, other activities associated with the construction of adjacent facilities would result in the disturbance and removal of vegetation over a potential of approximately 600 additional acres. With the exception of the tailing impoundment surface, the remainder of the disturbance would generally be reclaimed during the life of the project. If reclamation of the tailing impoundment area is successful, the area should return to it's productive timber raising capacity following completion of the project.

e. Stanley Creek Well Field and Mill Water Sump

The construction of the well field and mill water sump would result in the disturbance and removal of native vegetation over an area of approximately three acres. The area is presently a highly productive timber management area. If reclamation is successful the area should return to it's highly productive capacity following completion of the project.

2. Aquatic System Productivity

The cumulative effect of anticipated ASARCO activities, facilities and operations on aquatic productivity should not be significant provided reasonable precautions are taken to contain sediment from disturbed land areas and assuming that acid or toxic waters are not encountered in the mine or in the tailings seepage. The project will probably result in some increase in nitrogen and micronutrient levels in surface waters of the drainage, but without the simultaneous introduction of phosphorus, which is also limiting, aquatic productivity should not be measurably greater than it is now and nuisance algal growths will not be a problem.

The state's policy of nondegradation of existing high quality water (Section 69-4808.2) will apply to waters of the Lake Creek drainage. This policy reads as follows:

> (iii) The board (of Health) shall require that any state waters, whose existing quality is higher than the established water quality standards, be maintained at that high quality unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of these waters; and
>
> (iv) The board shall require any industrial, public or private project or development, which would constitute a new source of pollution or an increase source of pollution to high quality waters, referred to in subsection (iii) to provide the degree of waste treatment necessary to maintain that existing high water quality.

A measurable change in water quality, including a change in aquatic productivity that might affect a beneficial use, will be subject to enforcement action by the Department of Health and Environmental Sciences.

a. Site Specific Aquatic Productivity Impacts

(1) Mine Site

Potential impacts on aquatic productivity from the actual mining operation might be categorized as follows:

1) suspended solids resulting from disturbed land surface, i. e., waste rock patio and mine access roads,
2) suspended solids in the discharge from the mine portal,
3) acidity in the discharge from the mine portal,
4) toxic water (high in metals) discharged from the mine portal and
5) nutrients, mostly nitrogen, discharged from the mine portal.

Suspended solids and turbidity would have the effect of obscuring light needed for photosynthesis and of smothering benthic aquatic organisms if sediment cannot be contained before it reaches upper Stanley Creek, which appears to be a perennial stream at the site of the proposed operational adit. However, given the foregoing discussion (Page 305) it is not likely that sediment generation from the mine site would be significant nor is it likely, given reasonable precautions to contain it, that a large amount of sediment would find its way to Stanley Creek. Nevertheless, it should be mentioned that ASARCO exploratory drilling has caused an increase in sediment in upper Stanley Creek (see WQB memorandum and letter to ASARCO, Appendix H).

Acid mine discharge and the probability of encountering a body of toxic water in the mine are both very unlikely according to the preceding discussion (Page 306). Assuming there will be a discharge from the mine portal, and assuming that the discharge will reach Stanley Creek via surface or underground drainage, an acid or toxic discharge would significantly alter the biological structure and productivity of the perennial portion of upper Stanley Creek, perhaps to the point of eliminating the stream community as it now exists. But such an event is very unlikely because any water discharged from the mine portal probably will be similar in quality to the water presently discharged from the North Exploratory Adit.

If the commonly used mixture of ammonium nitrate and diesel fuel is used for blasting purposes in the mine, then there will be a significant load of nitrogen carried by the water discharged from the portal. When this mixture is wetted, it dissolves rapidly and releases both ammonia and nitrate. Nitrogen enters the water both from spilled powder and from blasting residue. An average nitrate-nitrogen level of 13.35 mg/l was reported for the Johns-Manville mineral exploration adit on the West Fork of the Stillwater River in southcentral Montana. Much higher levels were measured shortly after cessation of blasting (Botz 1976).

In 1977, several years after blasting in the ASARCO North Exploratory adit stopped, nitrate-nitrogen levels in the adit discharge were still measurably greater than background levels for the drainage (see Table II-10, Page 127). Initially, they were probably much higher, as they would be in the initial discharges from the operational adit. Much of this nitrogen would probably find its way into upper Stanley Creek, even if the intervening flow is underground. While a large slug of biologically-available nitrogen would have a significant effect on the biological makeup of the creek, i.e., the kinds of plants and animals living there, it probably would not have an appreciable impact on primary productivity. Production in Stanley Creek is limited chemically by phosphorus and micronutrients (see sections on Algal Nutrients and Algal Assays). Moreover, the cold water and deep shade of the upper Stanley Creek drainage would probably limit instream production to its present oligotrophic level, regardless of nutrient inputs. Consequently, there is little chance that Stanley Creek will become eutrophic as a result of nitrogen discharges from the mine portal. Much the same statement can be made regarding Lake Creek.

In the unlikely case of extremely low discharge from Bull Lake, high runoff from the Stanley Creek drainage and backflow into the lake, it is possible that some of the nitrogen discharged by the mine might eventually find its way into Bull Lake. Available nitrogen and phosphorus data for Bull Lake (Stearns-Roger 1975 and Hartman 1971) are quite variable and the lake's nutrient regime is unclear. The effects of any nitrogen additions to Bull Lake cannot be ascertained without algal assays and analytically sensitive nutrient analyses of Bull Lake water.

As stated previously an MPDES permit would be required for any discharge to Stanley Creek. Conditions of the permit are designed to maintain the basic chemical and biological character of the aquatic system and to disallow any significant alteration of stream quality (Appendix H).

(2) Mill Site

The mill site itself is not likely to have any significant effect on biological productivity in Stanley Creek because it would have no discharge and diversion of tributary streams around or through the plant would present a very minor water quality problem. Moreover, the chemicals to be used in ore processing are relatively nontoxic, alkaline waste (see letter from L. P. Parrish, EPA to A Horpestad, WQB, Appendix H).

A serious water quality problem with severe biological impacts would occur in the event of pipeline failure between the mill and the tailings thickener. The various degrees of potential impact are discussed in the previous section. A pipeline break or leak resulting in the introduction of fine inorganic material to upper Stanley Creek would have the following effects:

1) acute, short-term turbidity causing a depression in photosynthesis as the result of obscuring light penetration to benthic algae,

2) acute and chronic (3 to 5 years) smothering of benthic macroinvertebrates and attached periphyton organisms, and

3) possible chronic (3 to 5 years) metals toxicity to stream organisms.

Roughly 70 percent of the periphyton diatoms of upper Stanley Creek require a firm substrate for attachment, consequently a heavy load of fines deposited in this stream section would have serious biological consequences.

It is assumed that material spilled from a pipeline break between the mill and tailings thickener could be contained before it reaches lower Stanley Creek, except perhaps during times of heavy runoff. The residence time of this material in upper Stanley Creek probably would not be more than a few years given normal peak flow events. Because the Mount Vernon ore is low in pyrite and the tailings are likely to have an alkaline rather than an acidic reaction, solution of heavy metals in the tailings is unlikely. Thus, metals associated with the tailings in such a spill would probably be tied up initially with the sediment and be biologically inactive; however, if anaerobic conditions developed in the sediment following its deposition in the stream, the metals could go into solution and become toxic. But the probability of anaerobic (reducing) conditions developing in a steep gradient stream like upper Stanley Creek is low. To paraphrase the concluding statements from the previous section, failure of milling structures is rare and there should be no water quality impacts from these structures during the life of the operation.

(3) Mine Access Road

Reconstruction of the existing road up Stanley Creek, construction of a new road from the Bull River Highway (State Highway 202) and construction of a new bridge crossing Lake Creek would result in some relatively minor and short-term sedimentation problems. Given reasonable precautions for containing sediment, there should be no appreciable impact on aquatic productivity resulting from these construction projects. In the event that de-icing materials (salts) are used on these roads, it is unlikely that they would have a significant impact on aquatic productivity in the small concentrations that would ultimately find their way to surface waters. There is no known proposal for using herbicides for weed control along roadside rights-of-way.

(4) Transmission Line

Some road construction would be required for access to and maintenance of the proposed transmission line. If not property constructed, roads can ultimately result in the direct disturbance, through erosion and sedimentation, of a much larger area than is involved in the transmission line right-of-way.

Access road location is especially important. The risk for sediment and sedimentation is high when road construction occurs adjacent to a stream or must cross a stream. Also, steep mountainous areas with erodible soils are susceptible to soil mass movement and landslide erosion, the major sources of excessive sediment in aquatic systems (Fredriksen 1972 and Swanston 1970).

Tower site preparation areas and large cleared areas, necessary for maneuvering equipment, reduce plant cover and may increase sediment yield. A cover of trees and other vegetation tends to stabilize soil and minimize the transport of inorganic material. Its removal, particularly from steep slopes or near stream channels along the right-of-way, may lead to erosion and increased sediment and sedimentation in the stream systems.

Excessive organic debris associated with right-of-way clearance or road construction, if allowed to collect in streams can block the streams or cause a change in the dissolved oxygen content of the water.

Excessive removal of vegetation cover from beside small streams, as for right-of-way clearance, may increase the maximum water temperature experienced in the streams.

(5) Tailing Pipeline

Next to failure of the tailings storage facility, a break in the slurry pipeline would have the most serious aquatic biological consequences of any phase of the ASARCO operations. The effects would be very similar to those resulting from a break in the pipeline from the mill to the tailings thickener, but they would be far more severe because of the much larger volume of tails carried by the slurry line, and because of this line's closer proximity to lower Stanley Creek, Lake Creek and Bull Lake.

Extremely high suspended sediment levels and associated turbidity would cause a significant depression in photosynthesis for a short time following the spill. Roughly 60 to 90 percent of the algae and macroinvertebrates of lower Stanley Creek are sensitive to silt, which would either interfere with breathing or physically cover and kill sedentary organisms that cannot escape.

The fine inorganic material deposited in Stanley Creek as the result of a slurry line failure would probably have a residence time of three to five years or until the first major runoff event. Most of this material would eventually be deposited on the delta of Stanley Creek near the extreme lower end of Bull Lake (see Chapter II, Geomorphology). Metals toxicity in spilled tails probably would not be a problem, unless anaerobic (reducing) conditions developed in the much of the Stanley

Creek delta resulting in solution of the metals trapped there. Residence time on the delta would be indefinite and chronic toxicity cannot be totally ruled out.

Short of acute or chronic toxicity, the possible mobilization of metals and increase in alkalinity resulting from a tailings spill from the slurry line might have the effect of increasing primary productivity after the initial turbidity episode. Evidence from the algal assays suggests that productivity in Stanley Creek is limited by one or more micronutrients; if the right micronutrient(s) is (are) made more biologically available, then productivity might increase. But first there must also be an increase in phosphorus, which is unlikely.

The flow of Stanley Creek slows appreciably before it enters Lake Creek at the outlet of Bull Lake. Hence, at normal flows, much of the sediment from a spill would settle out before it enters Lake Creek. However, sediment could be flushed periodically from the Stanley Creek delta into Lake Creek at high flows. Conversely, in the unlikely case of backflow to the lake, some sediment might find its way into the extreme lower end of Bull Lake. Such sediment might suppress productivity by stripping nutrients from the water column.

Much more critical for Lake Creek is the short section of pipeline within the drainage of Lake Creek proper, particularly where it crosses the stream. A serious break and spill here would directly impact Lake Creek, which like Stanley Creek, has high percentages of attached and sensitive aquatic organisms. Residence time in Lake Creek would be about the same or slightly less than residence time in Stanley Creek. Much of the sediment resulting from a spill into Lake Creek would eventually be trapped behind the small hydroelectric dam just south of Troy. Until the sediment is flushed from the Lake Creek system, it would have much the same impact that it would have in Stanley Creek: an initial suppression of productivity due to turbidity and chronic smothering of attached or pollution intolerant organisms. It is unlikely in either case that riffles, the most biologically productive sections of these and other streams, would be totally inundated with silt. Silt would probably fill the rock interstices and accumulate on the lee or downstream side of large rocks or boulders. Thus, productivity would not be totally curtailed, even following a large spill.

(6) Tailing Impoundment

Failure of the tailings storage structure and release of the contained tails into Lake Creek would have the most severe impact of any ASARCO activity on the biology and productivity of Lake Creek. Lake Creek has exceptional diversity of aquatic plants and animals and consistently high percentages of pollution sensitive forms that would be smothered or physically covered by massive inputs of silt. The probability of such a failure, hence the probability of a major pollution event, is unknown.

More certain would be the infiltration of tailings pond water into the subsurface and subsequent passage of this water to Lake Creek.

Although levels of certain metals in the tailings water--silver, cadmium, iron, lead, copper, manganese, molybdenum, zinc and aluminum--exceed water quality criteria, they are expected to be well below these criteria following oxidation, sorption on soil particles and dilution with Lake Creek water. Consequently, no acute biological toxicity is expected to result from tailings pond seepage into Lake Creek. Tailings pond seepage of these micronutrients might lead to increased algal production because one or more of these metals appear to be limiting productivity in Lake Creek based on the algal assay results reported earlier. But, without simultaneous inputs of phosphorus, which is also limiting, algal productivity would not increase significantly. No additional phosphorus is expected to be added to surface waters of the Lake Creek drainage as a result of ASARCO operations.

(7) Stanley Creek Well Field and Mill Water Sump

No measurable effect on aquatic productivity is anticipated from operation of the Stanley Creek well field.

b. Cumulative Facilities Aquatic Productivity Impacts

(1) Periphyton

The Lake Creek drainage is one of the most pristine areas of Montana and perhaps of the Northwest being considered for a major mining project. The only significant impacts to date have been from logging and these should heal with time. Waters of the drainage are soft, hence they are relatively unproductive (oligotrophic) and susceptible to toxicity from heavy metals. In short, the aquatic system is fragile.

The periphyton community of the Lake Creek drainage, particularly of Lake Creek itself, has a diversity greater than that of most other streams in Montana. Higher in the drainage, where environmental conditions are naturally more austere (upper Stanley Creek), diversity is lower, as it is farther down the drainage in more productive waters (Kootenai River). Several diatom taxa have not been reported elsewhere in Montana and this may be their only residence in the state. The greater majority of the periphyton organisms require a firm substrate for attachment, consequently they are susceptible to inundation by sediment.

The potential exists for serious curtailment of primary productivity by catastrophic failure of either the slurry pipeline or the tailings pond. Particularly critical are stream crossings for the pipeline and the earth structure retaining the tailings alongside Lake Creek.

The cumulative effect of anticipated ASARCO activities, facilities and operations on aquatic productivity should not be significant provided reasonable precautions are taken to contain sediment from disturbed land areas and assuming that acid or toxic waters are not encountered in the mine or in the tailings seepage. The project will probably result in some increase in nitrogen and micronutrient levels in surface waters of the drainage, but without the simultaneous introduction of phosphorus, which is also limiting, algal productivity should not be measurably greater than it is now and nuisance algal growths will not be a problem.

A measurable change in water quality, including a change in algal productivity that might affect a beneficial use, will be subject to enforcement action by the Department of Health and Environmental Sciences.

(2) Macroinvertebrates

Much of the preceding discussion regarding cumulative impacts on periphyton and primary production is also pertinent to the macroinvertebrates and the first consumer trophic level. Most of the macroinvertebrates in the drainage are pollution intolerant and sensitive to sediment. Moreover, the soft waters of the drainage would render heavy metals more toxic to aquatic animals. The relatively pristine waters of the Lake Creek drainage have high diversities of macroinvertebrates and any significant change in water quality probably would result in a simplification of their benthic communities.

The potential exists for serious curtailment of secondary productivity by structural failure of either the slurry pipeline or the tailings pond. The cumulative effect of anticipated ASARCO operations on secondary (macroinvertebrate) productivity should not be significant provided reasonable precautions are taken to contain sediment from disturbed land areas and assuming that acid or toxic waters are not encountered in the mine or in the tailings seepage. Any improbable increases in productivity resulting from nutrient enrichment would be dampened at the consumer level. Autotrophic index measurements (see Page 136) indicate that both Lake Creek and Stanley Creek receive a considerable amount of preformed organic matter from either Bull Lake seston or from streamside terrestrial plants, or both in the case of Lake Creek. In the Lake Creek system, this externally derived organic matter is probably more important to macroinvertebrate nutrition than material produced autotrophically instream.

(3) Fish

The previous discussions concerning the potential for impact to the periphyton and macroinvertebrates as a result of the proposed project relate directly to the potential for impact to the fisheries of Stanley Creek and Lake Creek. Adverse impacts to these lower level producers and consumers would have a similar adverse impact upon the aquatic system's higher consumers, fish. It is not anticipated that the normal operation of the proposed facilities would adversely affect the fisheries of the area. During the construction of various facilities, the greatest risk for impact to the fisheries would originate with the potential for increased sediment transport into surface waters. Habitat alteration caused by sediment and sedimentation would, for the most part, be short-term, occurring during and immediately after construction activities.

Of the proposed activities, the upgrading and reconstruction of the mine access road and mill site preparation would have the greatest potential to generate increased sedimentation because of the close proximity to Stanley Creek. Construction of the transmission line and tailing pipeline would have similar impacts, although the potential for sedimentation would depend upon the final design location of the facilities centerline. The construction of the tailing impoundment and associated facilities, although near Lake Creek, would have a reduced potential for sedimentation because of the generally level terrain of the area.

The occurrence of sediment in rivers and Lakes is a natural phenomena and, as such, is not inherently negative. On the contrary, its geologic origin, physical and chemical characteristics, sources and concentration have helped to shape watersheds and determine which aquatic organisms live within them. These organisms have subsequently become selectively adapted to a set of environmental parameters characteristic of these watersheds and are very sensitive to changes in those parameters. Man's activities in these areas have the potential to place an additional burden or stress, in the form of increased sediment and sedimentation, upon these organisms. Their survival is dependent upon the extent of increased sediment and sedimentation, the resiliency of the organisms and the effectiveness of mitigation measures.

Sediment affects fish directly by reducing visibility, limiting the ability of the fish to locate food sources, clogging of gills by particulate matter and abrading external structures by the action of suspended solids (Phillips 1970, Saunders 1967 and Chapman 1962). The extent and magnitude of these impacts would be dependent upon many variables, including species, age and general health of the fish affected, water quality, the length of exposure to sediment, sediment particle size, shape, hardness and frequency of particle introduction.

Most authors conclude that concentrations of suspended solids must be very high to cause direct mortality of fish; in most cases, indirect damage to the fish population through destruction of the food supply, eggs or fry, or changes in the habitat probably occur long before the adult fish are directly harmed. Mortality of fish eggs caused by sedimentation is well-documented (Elser and Marcoux 1971, Saunder and Smith 1965 and Bianchi 1963). Clean permeable gravels provide nursery areas for fish embryos in the stream environment. Sediment in the water during the incubation period can greatly reduce the survival rate of developing embryos by clogging the pore spaces between the gravels. The supply of oxygen necessary for successful embryo survival diminishes, resulting in high embryo mortality (Peter 1962).

After hatching, fish fry depend on the crevices and interstices in the gravel along the stream bottom for cover and security from predators. Sedimentation can fill these spaces, eliminating escape cover. Phillips (1970) suggests that this increased vulnerability to predators may contribute to increased fry mortality.

The adult fish populations of Stanley and Lake Creek could be seriously affected if excessive sediment accumulation were to fill important pool areas, reducing available cover and hiding places (Saunders and Smith 1965). Bjornn et. al. (1974) working in Idaho, concluded that the summer and probably the winter, capacity of small mountain streams, where most trout reside in pools, will be reduced if sufficient sediment is added to a stream to reduct pool area or volume.

In addition to the direct impact potential as identified above, the sport fisheries of the general area may also experience indirect adverse impacts related to increased fishing pressure. Secondary development of the Bull Lake valley and adjacent areas would have the potential to increase the numbers of fishermen using the areas streams and lakes, often causing additional disturbance through careless activities. The potential for direct impact to the areas sport fishery through the development of housing or other development related construction immediately adjacent streams or other surface water is also present.

3. Terrestrial Wildlife

a. Site Specific Facilities Wildlife Impacts

Direct impact to many wildlife species that are known to occur on, or make use of, those areas proposed for direct disturbance during facility construction cannot be inferred without a comprehensive analysis of each specie. Although data collected for each of the areas proposed for disturbance provides a limited insight into the occurrence of wildlife at each site, it should by no means be considered comprehensive.

(1) Mine Site and Associated Structures

The tailed frog was located near the proposed main entrance adit. It requires clear, cold waters and would likely be lost from this area with mine development. The only recorded sighting of a hoary marmot in the West Cabinet Mountains was made at one of the proposed ventilation adit sites. Further development of this site may jeapordize this species in this area.

Mule, deer, moose, elk and black bear sign or observations were noted on those areas being considered for the location of the main adit. These species would likely be displaced and travel through the area would likely be modified or preempted.

Four species of birds were observed at this location including: Townsend's solitaire, hairy woodpecker, common flicker and chipping sparrow. Rodents noted at this development site or captured in snaptraps in the adjacent ABLA/MEFE habitat type included: vagrant and masked shrew, white-footed mouse, boreal redback vole, redtail chipmunk and red squirrel. Construction of the proposed facility could result in the displacement of or direct mortality of these species.

(2) Mill Site

Mule deer utilized the lower mill site during the fawning period. If mule deer were to fawn in this area, mine facility development would likely disrupt traditional use patterns. Deer sign noted during December above the upper mill site and on the upper east aspects of the Stanley Creek drainage documents early winter use of this area. A dead moose was found at the lower mill site and tracks indicate that this area is used during the winter by moose.

Snaptrap lines established at both mill sites had high trapping success. The greatest diversity of species and the relative abundance of each species at these sites indicate that this is a productive area in terms of small mammals. Facility development at these sites will constitute an irretrievable habitat loss. Rodent species captured or observed at this site include: masked and vagrant shrew, white-footed mouse, boreal redback vole, mountain phenacomys (montagne heather vole), redtail chipmunk and red squirrel. Snowshoe hare tracks were also noted at this site.

Five species of birds were noted at this location including: Steller's jay, gray jay, common raven, black-capped chickadee and golden-crowned kinglet. Within 800 m of the proposed lower mill site pika are located at the lowest elevations at which they were noted during this survey. Construction of the proposed facility could result in the displacement of or direct mortality of these species.

(3) Access Road and Utility Corridor

The consequences of widening the existing road, construction of a new road and road maintenance resulting in increased traffic and access would involve the potential for increased wildlife-vehicle collisions, increased poaching, vandalism and hunting pressure, as well as direct wildlife losses.

Black bear are known to concentrate along road right-of-ways during spring where green-up first occurs. This behavioral factor combined with over 300 mine workers and an established spring bear hunting season is likely to have adverse consequences for black bear of the Lake Creek Valley particularly along roads which will be used for commuting.

Small mammals which were captured in trap lines established in the TSHE/CLUN habitat type (representative of the proposed Mine Road) include: vagrant and masked shrew, white-footed mouse and redtail chipmunk. Species observed along the route include: Columbian ground squirrel, red squirrel and snowshoe hare. Construction of the proposed facility could result in the displacement of or direct mortality of these species

Although not found along the proposed route a barred owl and great horned owl were found dead along roads in the immediate area, apparent victims of collisions with vehicles. Dippers (water ousel) nest under the Stanley Creek bridge which may be replaced if the development is approved; if the surrounding habitat remains of a high quality they are likely to use the proposed bridge for nesting. Ruffed grouse use Stanley Creek for breeding but it is not known to what degree proposed development of the utility corridor would affect existing habitat. Other bird species observed along the proposed mine road include: mallard, common merganser, red-tailed hawk, rock dove, rufous hummingbird, common flicker, pileated woodpecker, yellow-bellied sapsucker, Steller's jay, gray jay, Clark's nutcracker, common crow, black-capped chickadee, mountain chickadee, American robin, varied thrush, Swainson's thrush, verry, golden-crowned kinglet, ruby-crowned kinglet, Bohemian waxwing, yellow warbler, yellow-rumped warbler, Townsend's warbler, common yellowthroat, pine siskin, dark-eyed junco, chipping sparrow and song sparrow. Construction of the proposed facility could result in the displacement of or direct mortality of these species.

Impacts associated with the mine road may be extrapolated to the entire utility corridor (road, transmission line, slurry pipeline and return water system) since they parallel one another for most of their length.

The proposed utility corridor would bisect an established mountain lion travel route, cross white-tailed deer and elk winter use areas and run the length of Stanley Creek which is extensively used by wintering moose. Movements along Stanley Creek by elk, deer and moose are indicated by tracks.

Potential effects of the proposed transmission line upon wildlife populations may be grouped into four broad categories: disturbance by construction, habitat changes brought about by timber removal, collisions of birds with wires and line-related human access. These general impacts have been described in some detail in the DNRC (1976) draft EIS on the Dillon-Clyde Park Transmission Project, and will be discussed below as they relate to the proposed ASARCO Troy Project Transmission Line.

Construction crews and timber-clearing operations can cause short-term displacement of birds and mammals, particularly larger mammals and large raptorial birds. This is expected to be insignificant where the centerline parallels existing roads except in the case of nesting raptors, as disturbance near the nesting site could result in loss of eggs or young or even nest abandonment. At least one osprey nest in the study area is believed to have been abandoned due to logging-related disturbance. Although no active raptor nests have been found within 0.5 miles of the centerline, it is likely that further study would reveal nest sites vulnerable to disturbance.

Removal of the forest canopy to accommodate poles and wires changes both habitat configuration and the availability of food and cover to animals using that habitat. This may improve or degrade habitat suitability, depending upon the particular species involved. It is likely few trees will be removed from the right-of-way where the older distribution line is simply being replaced; here, habitat changes will be small and will not affect vertebrate populations significantly. However, where new line and access roads must be built, timber clearing and road construction may result in large-scale habitat alteration.

The southern five miles of the proposed transmission line would cross dense, moist forests, predominantly seral stages of the western red cedar-western hemlock/queencup beadlily habitat type, but extending near the southern extremity of the route into the subalpine fir/queencup beadlily h. t. and, along Stanley Creek, into the western red cedar/devil's club h. t. These are among the most mesic habitat types in Montana and support a luxuriant shrubby understory providing abundant browse and cover. Timber clearing in these types may stimulate browse production, but browse availability is probably not limiting to mule deer and elk in these situations. Increase in browse production is likely to be offset by effects of the proposed hauling road parallel to the centerline (see below). Effects of these habitat changes on populations of smaller birds and small mammals would likely not be significant.

Slash piling along the right-of-way could impede movements of large ungulates and such slash should be disposed of soon after right-of-way clearing.

The proposed transmission line would cross Lake Creek in three places, creating the risk of collisions of waterfowl and other riparian birds with the wires during storms or heavy fog. This would be a small but long-term source of avian mortality.

Normally, long-term disturbance of large vertebrates by traffic or other human activity would be of minor significance in an area such as this, where use of the roads would not be heavy and where access roads could easily be closed. Also, most of the proposed transmission line route parallels on existing roads which would be used for line access. However, the problem of line-related access would be compounded in this case by the proposed hauling road, which would parallel the line from Highway 202 to the plant site. The disturbance to vertebrates, particularly large ungulates, by the heavy traffic on this road could be considerable and could be expected to reduce animal use of the area--and hence carrying capacity. The potential effects of line-related access in this case would be clearly overshadowed by the effects of the hauling road, and could only be mitigated by keeping the line and hauling road in the same right-of-way, as proposed.

The proposed tailing pipeline would extend nearly the full length of the Stanley Creek drainage and may constitute a temporary obstacle to the movements of some wildlife as well as some habitat loss associated with it's construction. Impacts associated with the pipeline would be similar to those identified for the transmission line and mine access road.

A failure or spillage of tailing from the pipeline resulting in a deposition of tailing in Stanley Creek or Lake Creek would have adverse affects of the populations of beaver and muskrat presently using these areas.

(4) Tailing Impoundment

Construction of the tailing impoundment would result in the displacement or direct mortality of several species of small mammals presently known to occur on the site. Of these species, Columbian ground squirrels likely provide an important role in the diet of redtailed hawks, American kestrels, coyotes and mountain lions, all of which were noted at this site. Also noted at the site of the proposed tailing impoundment were Pacific tree frogs, black bear sign and spruce grouse. In addition, mountain bluebirds were common at the site. These species, the bluebird in particular, would be adversely affected by the construction of the proposed facilities. The mountain bluebird is a relatively unadaptable species because of it's specialized nesting requirements. In northwestern Montana where open terrain is usually artificially maintained, habitat for open country species is limited. The reduction of the open country of the tailing impoundment site would lessen this valuable resource for wildlife for the life of the mining operations.

Based on numerous tracks, pellet groups, beds, feeding sites and observations of elk, deer and moose, the proposed tailing impoundment area constitutes an important winter use area for ungulates. Construction of the impoundment would eliminate approximately 400 acres of this winter use area. In addition to this direct habitat loss, movements of wildlife between Lake Creek and Highway 202 could be hampered. The resultant habitat reduction, and/or restricted movements could have the effect of concentrating wildlife on more limited areas, causing an over utilization of the remaining adjacent habitat and an overall reduction in carrying capacity of the area.

Three species of waterfowl and two species of shorebirds were observed using a natural pond at the site of the proposed impoundment. In addition, several other birds species are known to occur on the site. The construction of the proposed tailing impoundment would result in the displacement of, and/or mortality of these species, as well as a reduction in suitable habitat.

(5) Stanley Creek Well Field and Mill Water Sump

The area proposed to be used as the site of the well field and mill water sump facilities is a regenerated clearcut that provides forage for wintering white-tailed deer and moose. In addition, mule deer use the area during the spring months. Development of this area for the proposed facilities would remove the area from wildlife use, possibly concentrating wildlife in other areas with limited carrying capacity. Other species observed on the proposed site include the Columbian ground squirrel, white-footed mouse, vagrant shrew, Steller's jay, gray jay, common raven, common crow and black-capped chickadee. These species would be displaced and/or suffer direct mortalities if the proposed construction of these facilities were to occur.

b. Cumulative Facilities Wildlife Impacts

The direct influence of over 300 mine workers, as well as an increase in the general population growth of the area would likely be the single most significant impact upon wildlife of the Mt. Vernon-Stanley Creek area and the Lake Creek valley related to the proposed mine development.

As a result of the data obtained during the April 1977-March 1978 wildlife survey of the general area of the proposed ASARCO Troy Project mine development (Joslin 1978), the mountain goat was identified as having the greatest potential to experience adverse impacts should the mining proposal be implemented. Other species having a significant potential for adverse impacts, either directly as a result of mining development related disturbance or secondarily through increased population growth in the area include moose, black bear and osprey. Although the occurrence of grizzly bear in the immediate area proposed for mine development was not documented (Olson,Elliott 1978) there would be a significant potential for adverse impacts to the species caused by an increase of people-bear encounters if grizzly bear were to occur in the area and the mining proposal were implemented.

(1) Herpetofauna

Information regarding amphibians and reptiles was collected as the opportunity arose and therefore, definitive conclusions regarding impacts to species other than the tailed frog would be presumptuous. The tailed frog, classified by the Montana Department of Fish and Game as a "nongame species of special interest or concern" (Flath 1977) was located in Stanley Creek in the immediate vicinity of the proposed mine. Water removals from Stanley Creek, erosion from adit patios, or creek alteration during the course of mine development would adversely affect this species in this area. Tree frogs were found at the proposed tailing impoundment site and would be lost at this site. All eight species of herpetofauna noted during this investigation as well as those indicated by other investigators as likely to occur in this area of the state would be adversely affected if proposed mining disturbance corresponded to areas utilized by herpetofauna. The scope of this study did not allow a comprehensive investigation of herpetofauna of the area but all species noted in Chapter II are likely to receive local adverse impacts.

(2) Birds

(a) Waterfowl

Waterfowl which utilize Stanley Creek and Lake Creek (below its confuence with Stanley Creek) may suffer adverse effects if the safety features designed for the slurry pipeline or tailing impoundment fail and pollution of these drainages result. Waterfowl which use Stanley Creek would likely be displaced during the construction of the proposed road, pipeline and transmission line. No waterfowl broods were noted on Stanley Creek; however, the creek is concealed from view along most of its course by terrain and vegetation. The common mergansers and pair of mallards observed on Stanley Creek may indicate breeding use and Lake Creek is documented as important breeding habitat for common mergansers. A pond on the proposed tailing impoundment site was used by mallards, common goldeneye (brood of seven), green-winged teal and blue-winged teal. These species as well as others which may use the pond would be displaced, and this area permanently lost with regard to its feeding and brood rearing capabilities if the proposal is implemented.

The proposed tailings pond is not likely to receive concentrated waterfowl use because natural shoreline habitat will not be present. Residues from reagents as well as the active tailing deposition process would further preempt natural production of macroinvertebrate waterfowl food or palatable aquatic vegetation.

Increased human abundance resulting in the likely occurrence of increased vandalism, poaching and hunting pressure would contribute to the impacts on waterfowl of the Lake Creek valley and particularly of Bull Lake.

(b) Raptors

Information collected during this study suggests that of the 15 species of raptors observed on the study area (Chapter II) osprey would have the greatest potential for receiving impacts if the proposal is implemented.

Johnson and Melquist (1973) indicate that threats to raptor nesting success and consequent population stability include shooting, pesticide-induced reproductive failure, heavy metal contamination, nest molestation and habitat alteration. At least three of these possibilities exist in association with the proposed ASARCO mine development.

Shooting of raptors has already been reported from the area and in Idaho "shooting is almost certainly the primary cause of mortality in osprey populations" (Johnson and Melquist 1973). Increased use of the Lake Creek valley because of human population growth would likely add to this type of loss.

Heavy metals from the proposed ASARCO copper-silver mine development may escape into the environment as was the case in Idaho where Mink, et. al. (1971) indicates that despite the construction of settling ponds in the Coeur d'Alene River mining area, heavy metal (cadmium and zinc) levels remained high, both from seepage and from erosion of old tailings. The effects of heavy metal contamination from zinc, lead, iron and copper in the Coeur d'Alene River upon osprey reproduction is under investigation (Johnson and Melquist 1973).

Raptor habitat has been more widely altered from logging activities in the area than it would be from proposed mining developments. Removal of the forest canopy creates areas which are used by open area species such as red-tailed hawks and kestrels, but at the expense of forest dwellers such as the goshawks, sharp-shinned hawks and owls. The clearcut area of the proposed tailing impoundment currently provides a food source of ground squirrels and smaller mammals which are used by red-tailed hawks and kestrels. Some habitat of both forest and open country raptors would be lost in mine facility and tailing impoundment development.

The possible occurrence of the endangered peregrine falcon on the study area requires further investigation before it can be determined whether this species, if it occurs, would be affected by the proposed mine and associated activity. The bald eagle (also an endangered species) was observed during migration along Bull Lake. Potential impacts to this species are discussed on Page 342. A barred owl and a great horned owl were found dead on roads, apparent victims of vehicle collisions. This type of loss would be expected to increase with increasing vehicle traffic in the Lake Creek Valley.

Forest dwelling hawks including the goshawk, sharp-shinned hawk and Cooper's hawk would likely be less impacted than the open area hawks including red-tailed hawk and American kestrel (sparrow hawk) which would likely be displaced from the tailing impoundment area if the proposal is implemented. This area is consistently used by redtails and kestrels for hunting rodents and other small mammals and birds.

(c) Forest Grouse

Blue grouse, ruffed grouse and spruce grouse were observed on the study area although spruce grouse were positively identified on only one occasion. Ruffed grouse were the most commonly observed of the three grouse on the study area. Widening of the road, maintenance clearing and construction of the tailing pipeline and transmission line, disturbance and construction at the well field and sump site as well as inundation and maintenance of the tailings pond area will have adverse consequences for ruffed grouse. The rarely observed spruce grouse may also be adversely affected at the tailings impoundment site. Long term consequences of transmission line development may result in shrubby areas which may be used by grouse. Although artificial openings such as those created through logging and fire may provide additional habitat for ruffed grouse, few areas as will be opened and allowed to revegetate into shrubby areas during this development.

Blue grouse are not likely to be impacted from proposed mine activities unless the road from Stanley Creek over Mt. Vernon to Ross Creek is used. Blue grouse were regularly observed on the south aspect of Mt. Vernon on the road and on the ridge between and Spar Peak. If the south adit were activated or the south side road were used regularly, blue grouse may receive increased poaching and hunting pressure.

(d) Shorebirds

Proposed mine developments which may adversely alter or diminish breeding and feeding habitat of shorebirds on the study area involve the tailing impoundment, tailing pipeline and return water system. Spotted sandpipers and killdeers were recorded using the mudflats along a pond at the proposed tailing impoundment site. Common snipes and gulls may also use this area although they were not noted specifically at this site. Shorebirds may incur impacts similar to those which could be expected for waterfowl.

(e) Other Birds

Sixty-nine bird species which were observed on the study area are included in this category. Over 80 percent of the birds in this category belong to the Order Passeriformes which are perching or song birds. If it is assumed that bird species are selecting individual habitat types to fulfill a portion of their life's requirements, then it can be assumed that the birds observed in the habitat types which would be affected by the proposed ASARCO development may be affected as well. The TSHE/CLUN and THPL/OPHO habitat types are present in the areas to be impacted and 45 bird species were observed to utilize these habitat types during the study. Species which were observed specifically utilizing the area proposed for the tailings pond site included: woodpeckers, flycatchers, swallows, mountain bluebirds, starlings, warblers and western meadow larks. Mountain bluebirds, in particular, because of the abundance of nesting sites on the proposed tailing impoundment area may be adversely affected. Power (1966) notes that "Highly specialized nesting requirements have produced a relatively unadaptable species whose population has declined as a result of environmental changes of recent decades".

(3) Mammals

(a) Rodent-like Mammals

This diverse group of species plays an important role in the food web at the base level. Alteration of their habitat may have far reachings impacts upon the variety of predators which rely upon them for survival.

Based on small mammal abundance data collected at trapping sites, mining activities would apparently have the greatest impacts at the following sites in decreasing order of importance: upper mill site, THPL/OPHO site (slurry pipeline), ABLA/MEFE site (adjacent to mine adit), lower ore mill site, tailings pond, TSHE/CLUN sites (representative of most proposed activities), well field and mill water sump site. Snaptraps were not capable of capturing Columbian ground squirrels which were abundant at the proposed tailings pond site. Development of all proposed mine and facility sites would have some impact to this group of animals.

A hoary marmot was noted at the mine ventilation adit. Additional development may displace or destroy hoary marmots at this site, which is the only site in the West Cabinet Mountains where they have been recorded.

Water withdrawals from Stanley Creek (or the ground water which feeds Stanley Creek) for utilization in the proposed mining operation if it resulted in a reduced flow in Stanley Creek could have an adverse effect upon the beaver and muskrat in Stanley Creek. Beaver require deep water to winter. Muskrats are particularly vulnerable to water level fluctuations and would therefore, be more affected than beaver if lowered water levels occurred in Stanley Creek. Should the creek become polluted there would likely be adverse effects upon animals associated with water along both Stanley and Lake Creeks.

(b) Carnivores

(i) Black Bear

Although overall food availability is not likely to be limiting for black bears, critical spring range may concentrate bear in vulnerable situations which often occur along road right-of-ways where green-up first occurs. The shoulders of the proposed mining road would green-up early because the road will be plowed and heavily used. The attraction of bears to this area for spring feeding may incur casualties to bears through collisions, as well as result in increased poaching and spring hunter harvest. Until black bear denning areas, critical seasonal foraging area and travel routes are determined, a comprehensive analysis of potential mine-related impacts to black bear cannot be made.

(ii) Weasel Family and Raccoon

Members of the weasel family and raccoon would not likely experience direct impacts from mine development unless pollution of Stanley Creek or Lake Creek occurred. In this case mink, river otter and raccoon would be most affected. Secondary losses to this group of animals because of activities which affect their food source could occur. A significant reduction of animals in this group which have a marketable fur, would directly affect local trappers.

(iii) Coyote and Fox

Over 50 instances of coyote sign or observations were collected on the study area but fox were not noted and according to local residents they are rare in this area. Coyote would be displaced from the site of the proposed tailings pond which they currently use to hunt small mammals. Information regarding these species was collected incidental to other activities, therefore, definitive conclusions regarding mining impacts upon them cannot be made.

(iv) Mountain Lion

Information collected during this investigation indicates that the Mt. Vernon-Stanley Mountain-Keeler Mountain-Lake Creek complex is extensively used by mountain lions. Eight different lions were known to use the Stanley Creek drainage during the 1975-1976 period (Chapter II). Mountain lions are known to cross Stanley Creek between Stanley Mountain and Keeler Mountain as they move from one hunting area to another. These movements may be hampered or the quality of the area diminished with respect to mountain lion if the proposal is implemented.

Secondary impacts to lions may occur through reduction of their prey species (deer, beaver, hare, ground squirrels, etc.). Reduction of these prey species may occur because of direct removal by people or through displacement and attrition caused by loss of habitat.

The full impacts of the proposed mine and facility development, operation and increased human numbers on the mountain lions of this area are not known. Activity which disrupts use patterns, or removes habitat (either physically or through behavioral modifications of the lions) would have a long-term adverse effect upon the mountain lions of this area. The short-term direct mortality imposed through mountain lion hunting would probably remain constant unless future area residents are also houndsmen.

(v) Bobcat and Lynx

Bobcat tracks were noted throughout the study area but were particularly abundant in the Stanley drainage on Keeler Mountain and along Keeler Creek.

This area would receive increased vehicle traffic which may affect bobcat use of these areas for hunting snowshoe hare. According to local residents lynx occur in the area but no definitive sign was noted during this study. Information regarding these species was collected incidental to other activities, therefore, definitive conclusions regarding mining impacts upon them cannot be made.

(c) Ungulates

(i) Elk

Based on information gathered during this study, the proposed mining development would probably incur adverse impacts to the elk which use the area. One hundred seventy elk were observed during this investigation but almost 83 percent of these were observed during the summer and early fall period. The data do not provide a sufficient base of information to draw definitive impact conclusions regarding late spring calving areas or spring and late fall migration routes. The Stearns-Roger report (1975) hypothesizes that elk migrate from Keeler Mountain and around the north end of Stanley Mountain, across the north face of Mt. Vernon on their way to summer range. They postulate that since elk are known to calve en route to summer range that the clearcut areas of Stanley Creek may provide the necessary open but brushy calving habitat. During spring of this survey, calving areas were not noted. One observation of elk each was made on Mt. Vernon and Stanley Mountain during late Summer suggesting that a small group may use this area year round.

The data are too limited to support or refute the hypothesized elk migration routes presented by Stearns-Roger (1975). If elk do use Stanley Creek to gain access to the Mt. Vernon-Spar Peak ridge during spring migration (the reverse in the fall) mining activities would affect their movements but how and to what degree is not known.

Elk sign and observations collected during this study indicate that Stanley Mountain, the mouth of Stanley Creek, the east aspects of Mt. Vernon along Bull Lake, the north end of Bull Lake and the lower section of Camp Creek as it enters Lake Creek all receive substantial winter use by elk (Joslin 1978). The areas described are adjacent and constitute a unit of land. Portions of this area would receive direct impacts from the proposed mine development, and the surrounding areas would likely receive secondary human impacts through increased poaching and hunting pressure. The fact that winter range as defined by the Forest Service (Figure II-11) does not encompass portions of these areas may mean additional impacts to the elk of this area. Areas not designated as winter range by the Forest Service fall into alternate management categories which, through the planning process, may be allocated for logging or alteration so that additional hardships for elk may occur over and above the impacts which would materialize with implementation of the proposed mining endeavor. Impacts to this area, when they originate from different sources become synergetic in their effect upon wildlife. The potential of cumulative habitat alteration in this area must be addressed in order to comprehend the total impacts to wildlife. If the areas not currently delineated by the Forest Service are managed for purposes other than wildlife, and if the mining proposal is implemented, impacts to elk would be significantly greater than if mining were the only activity occurring in the area.

(ii) Mule Deer

If access to the Mt. Vernon ridge by either the Stanley Creek or Ross Creek roads is improved, or if use of either road is increased by mine company personnel the probability of mule deer losses through poaching, increased hunter access, or collision with vehicles would increase. Disruption of travel by deer along traditional routes and displacement of mule deer from regularly used areas may result in the area having a lowered carrying capacity. Stanley Creek appears to be used as a travel route by mule deer during spring and fall, based on observations and deer sign collected during this study. Mule deer use of the lower mill site during spring by females suggest that this area may be used as a fawning grounds. Numerous tracks, pellet groups and beds of deer, presumed to be mule deer, were noted during December on the slope immediately above the proposed upper mill site. During the summer mule deer were regularly observed on Mt. Vernon and along the ridge between Mt. Vernon and Spar Peak.

Winter use areas of mule deer cannot be definitively designated due to the limited amount of data gathered during that season. However, because mule deer were not observed as often as elk, white-tails or moose, it was deduced that mule deer were using areas at higher elevations which were not surveyed as often during the winter months. Deer sign observed during January in 76.2 cm (30 inches) of snow on Keeler Mountain was thought to be mule deer and local residents indicate that mule deer winter at these higher elevations. Delineation of big game winter range by the Forest Service is particularly critical when the future of wildlife habitat in an area may be determined by any one of a range of management options. Omissions of an area which is used by big game may have serious consequences. The concept of synergistic impacts to wildlife from more than one activity in an area is discussed for elk.

(iii) White-tailed Deer

White-tailed deer were observed utilizing habitat associated with the lower elevations of the Lake Creek valley more than the other ungulates on the study area. Of all proposed mining activities it appears as though the tailing impoundment would have the greatest potential to affect white-tails. It is not known to what degree white-tails rely upon the several hundred acres of valley bottom which is proposed to be inundated or disturbed through roading and construction. In addition to this direct habitat loss, movements of wildlife between Lake Creek and Highway 202 may be hampered. Habitat destruction and/or restricted movements could have the effect of concentrating wildlife on more limited areas, resulting in over utilization of the remaining habitat and an overall reduction in carrying capacity of the valley.

Areas receiving heavy deer use (based on deer sign data) include Ross Creek, south, west and north shore of Bull Lake, Stanley Mountain, Keeler Mountain, Lake Cree, Camp Creek, Grouse Mountain and Highway 202 between Felix and Twin Creek.

Delineation of big game winter range by the Forest Service is particularly critical when the future wildlife habitat of an area may be determined by any one of a range of management options. Omission of an area which is used by big game may have adverse influence on these species. The north ends of Stanley and Keeler mountains are such examples of area used by white-tails. The concept of synergistic impacts to wildlife from more than one activity in an area is discussed for elk and is pertinent here.

(d) Moose

The entire length of Stanley Creek, the Lake Creek flats and Copper Mountain were extensively used by moose based on 87 instances of sign and observations (Joslin 1978). Moose were apparently less abundant than other ungulate species present on the study area (except for bighorn sheep) and since proposed mining activities and moose winter use areas are coincident, moose are likely to realize adverse impacts. The Forest Service has not delineated Stanley Creek as moose winter range. On-the-ground reconnaissance during this study revealed that this area was extensively used by moose during the winter (1977-1978).

Development of the mining proposal could have the effect of reducing the area's carrying capacity of moose in addition to the more obvious losses which may occur through increased poaching and hunting pressure. Cumulative impacts to moose from all pending or existing activities in the Lake Creek Valley would have to be addressed before definitive conclusions regarding the impacts to moose could be made.

(iv) Bighorn Sheep

Two bighorn ewes which were wearing neck bands were observed on several occasions on the south side of Mt. Vernon near ASARCO's south adit. If use of the road over Mt. Vernon between Stanley and Ross Creeks were to increase, these bighorn sheep could be displaced.

At this time it is not known whether Mt. Vernon has assumed an essential role in the life requirements of these sheep which were planted on Berray Mountain in 1975 by the Montana Department of Fish and Game. Further investigation would be required to determine if Mt. Vernon is indeed utilized on a yearly basis by bighorn sheep.

(v) Mountain Goat

Information collected during this survey suggests that mountain goats will not benefit from development of the Mt. Vernon copper-silver deposits and that they are likely to suffer adverse impacts through habitat destruction, alteration or availability.

Because of the mountain goats specific use of Mt. Vernon and because of the unique management problems related to mountain goats, special emphasis was directed to the understanding of this herd's status, productivity and well-being. Declines in mountain goat populations throughout their range, from a variety of man-related causes, have sparked concern over the status of this species. During the last 20 years coal mining, logging, industrial disturbance and increased hunter access have seriously impacted the once thought "secure" mountain goat and it's habitat.

Mountain goats, throughout their range, have not received the attention that other ungulates have, primarily because of manpower and monetary constraints (Hebert 1977), the low level priority as a big game species (Stoneberg and Foss 1977, Phelps, et. al. 1975) and the belief that "the goat is one big game animal not displaced by the encroachment of civilization" since "their rugged habitat is unsuitable for man's purposes" (Foss and Rognrud 1971). Recently however, goats have received increasing attention as sportsmen, aesthetic and general environmental interests intensify.

Today, the mountain goat and its habitat is not as secure as once thought and declines in goat herds have been documented from Alaska (Ballard 1977), British Columbia (Phelps, et. al. 1975), alberta (Foster 1976) and Idaho (Kuck 1977). These investigations have sparked concern over the status of these herds and the possibility that others may be similarly suffering.

Ballard (1977) reported that several herds in Alaska have received excessive hunting pressures as an indirect result of road development. He also indicated that clearcut logging in goat travel corridors, and adjacent to wintering areas may prove detrimental to goat populations. Foster (1976) noted: "In the East Kootenai region mountain goat were formerly abundant (Seton 1927) until industrial disturbance directly destroyed crucial winter ranges and indirectly depleted local stocks through means of increased hunter access (Kerr 1965 and Phelps, et. al. 1975)". Phelps, et. al. (1975) documented drastic goat declines in British Columbia resulting from mismanagement of hunter harvests. In this case declining population was being masked by a consistent yearly harvest which had been artificially maintained through road development and subsequent access into previously undeveloped terrain. Pendergast and Bindernagel (1977) documented the incompatibility of coal mining and related activities with goat populations in northeastern British Columbia. In Washington, Johnson (1977) noted a loss of good goat habitat from fire control and disturbances caused by new roads and logging activity. In Idaho, Brandborg (1955) indicated that "the major decline in the mountain goat populations on the Salmon River during the present century can apparently be attributed to two factors: (1) the influx of prospectors and placer miners into the area during the depression years and (2) construction of the Salmon River road in the 1930's which made herds more accessible than at any previous time". Stoneberg and Foss (1977) indicated a decline in the Crazy Mountain herd of Montana as a combined result of a natural leveling-off process subsequent to population eruption of an introduced herd and hunting mortality.

Hjeljord (1973) noted a lack of dispersal in introduced herds and Geist (1971) noted the same in sheep and said that "natural repopulation of former range is unlikely for sheep and other 'k-selected' species (goats) for which exploitation of its range is a function of its social system and home range knowledge". Because of the strong instinct in mountain goat nannies to return to the same winter range year after year (Kuck 1977) the Mt. Vernon herd should be expected to suffer adverse consequences should use of the Spires are be preempted through mine related activities.

Mountain goat extripation through logging activities and access development in the Keeler Creek drainage exemplifies the syndrome which was observed in British Columbia (Phelps, et. al. 1976). Up to 20 years hence, only one goat was observed in the Keeler Creek area although it is within easy walking distance of the Savage Mountain area. Once extripation occurs, natural reestablishment is evidently a slow process.

Since mountain goat winter range is naturally limited by a combination of rugged terrain and severe weather, human disturbance through habitat destruction, alteration or availability would be an additional hardship--a hardship which possibly cannot be accommodated by a species having strong homing tendancies (Kuck 1977), limited pioneer ability (Geist 1971) and high natural mortality rates (Casebeer, et. al. 1950 and Brandborg 1955).

A careful look at mountain goat herds faced with habitat disruption, access development or human activities which may modify goat behavior is necessary if current levels of goat populations are to be ensured. Mountain goat habitat, whether it is directly or indirectly lost cannot be replaced.

(d) Endangered or Threatened Species

The proposed project would not directly impact the key habitat of any of the endangered or threatened species in the general vicinity of the project. An indirect impact on these species would be associated with the increased number of people settling in the Lake Creek valley as a result of the mine development and operation. These impacts could include increased shooting, harassment and pesticide or herbicide poisening.

(i) Peregrine Falcon

The possible occurrence of the peregrine falcon on the study area requires further investigation before it can be determined whether this species, if it occurs, would be directly affected by the proposed mine and associated activity.

(ii) Bald Eagle

The area proposed for direct disturbance during the life of the mining project does not include habitat identified as critical for Bald Eagles. The proposed transmission line could result in increased eagle injury or mortality associated with collisions with the lines. The proposed spacing of the transmission line conductors is adequate to prevent accidental eagle electrocution. Eagles are sensitive to increased heavy metal concentrations and would be adversely affected if the concentrations of heavy metals were to increase in their food supply as a result of accidental contamination related to the proposed project.

(iii) Gray Wolf

The area proposed for direct disturbance during the life of the mining project does not include habitat identified as critical for gray wolves. The occurrence of the gray wolf in this area is unknown and unlikely.

(iv) Grizzly Bear

The proposed ASARCO mine has the potential to adversely affect the potential for bear/human encounters. There would also be the likelihood that the mine could adversely influence grizzly bear management options such as habitat enhancement, relocations and providing relatively undisturbed habitat. Conflicts could be minimized by a diligent effort by ASARCO to minimize human access and nonessential use in and adjacent to core grizzly habitat. Human access to the ridge complex leading east and west from Mt. Vernon is particularly important, as is access to the south facing slope of Ross Creek where a road system is currently located. It can also be predicted that grizzlies will use mesic sites that provide a high abundance of bear foods such as those on the north aspect slopes of Mt. Vernon.

A factor which could influence bear/human encounters is the attractiveness of the mine site to grizzlies. Situations where garbage is available would attract bears. Seeding and fertilizing grass and clover would also attract bears, often into places where human use would be on a regular basis such as roads.

The information on these studies have been furnished to the U. S. Fish and Wildlife Service, Billings, Montana, with a request for a biological opinion as required by the Endangered Species Act. An opinion has not been given at this date but is expected in June 1978.

C. The Social and Economic Environment

1. Baseline Forecasts Without the Proposed Mine

This section presents information on the social and economic environment for Lincoln County, assuming the absence of the ASARCO mine. This is done to provide a background for a consideration of the magnitude and significance of the impacts, given the presence of the ASARCO mine, as they relate to a future without these impacts.

a. Employment and Population Projections

The projections presented in this section use the procedure discussed in Appendix U. As indicated above, population levels are critically tied to assumptions pertaining to basic employment. The basic employment projections for Lincoln County, including the additional dam related construction, are shown in Table III-3.

A number of comments are in order in regard to the preceding basic projections. First, it should be emphasized that the projections of basic employment were entirely judgmental. Judgments were based on discussions with major firms within the state, the Montana Employment Security Division, university economists, as well as a review of historical employment data. No attempt was made to formally project basic activity levels. Second, for the Federal Government, Railroad, Other Manufacturing and Agriculture sectors; it was assumed that past trends would continue into the future. However, the projections were not a simple extrapolation of past data. In the case of Agriculture, it was further assumed that the rate of decline in employment would level off at about 1 percent per year. Third, construction employment estimates were based on anticipated employment for Corps of Engineers' projects related to the Libby Dam. Fourth, the downward employment trend in the Wood Products industry was assumed to bottom-out in 1978 and 1979 with a slight growth projected for subsequent years. Fifth, baseline Mining employment was projected to increase as a result of a gradual expansion of vermiculite activity.

Once basic employment was projected, county baseline population projections were computed. Table III-4 presents these projections and the calculations on which they were based.

Table III-3 Basic Employment Projections

Sector	1977	1978	1979	1980	1981	1982	1983	1984	1985	1990	1996
Permanent Basic											
Agriculture	218	216	214	212	210	208	206	204	202	192	180
Federal Government	460	470	480	490	500	510	520	530	540	590	650
Other[1]	1778	1738	1748	1773	1798	1823	1848	1873	1898	1898	1898
Total Permanent Basic	2456	2424	2442	2475	2508	2541	2574	2607	2640	2680	2728
Temporary Basic											
Construction	177	245	276	410	520	452	275	80			
Total Basic	2633	2669	2718	2885	3028	2993	2849	2687	2640	2680	2728

[1] Other includes mining, manufacturing and railroad transportation. Individual sector totals were not listed to avoid possible disclosure problems.

Table III-4 Baseline Population Calculations Lincoln County

Year	Permanent Basic Employment	Nonbasic Employment Multiplier	Permanent Nonbasic Employment	Total Permanent Employment	Population Multiplier	Permanent Population	Temporary Construction Employment	Temporary[1] Population	Total[2] Population
1977	2456	1.310	3217	5673	2.830	16,055	177	404	16,500
1978	2424	1.315	3183	5607	2.820	15,812	245	559	16,400
1979	2442	1.316	3214	5656	2.810	15,893	276	629	16,500
1980	2475	1.320	3267	5742	2.800	16,078	410	935	17,000
1981	2508	1.325	3323	5831	2.790	16,268	520	1186	17,500
1982	2541	1.330	3380	5921	2.780	16,460	452	1031	17,500
1983	2574	1.335	3436	6010	2.770	16,648	275	627	17,300
1984	2607	1.340	3493	6100	2.765	16,867	80	182	17,000
1985	2640	1.350	3564	6204	2.760	17,123			17,100
1990	2680	1.380	3698	6378	2.720	17,348			17,300
1996	2728	1.425	3860	6588	2.675	17,623			17,600

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[1] Computed as employment times average family size (2.28) for construction workers.

[2] To the nearest hundred to avoid spurious accuracy.

The following example illustrates the calculation of Table III-4:

$$1980 = (2475^{1} \times 1.32^{2}) + 2475^{3} \times 2.800^{4} + 410^{5} \times 2.28^{6} = 17{,}000$$

[1] Permanent Basic Employment.
[2] Nonbasic Employment Multiplier.
[3] Permanent Basic.
[4] Population Multiplier.
[5] Construction Employment.
[6] Average Family Size.

Permanent Population + Temporary Population = Total Population

As in the example of the previous section, no secondary employment effects were allocated to (temporary) construction activity. Also, changes in projected population multipliers (natural increase population to employed labor force ratios) were calculated using the modified cohort model. Changes in employment multipliers over time were assumed to change in direct relationship to the population multipliers. This direct link rests on the premise that changes in nonbasic or service employment are largely the result of increased labor force participation, the number of individuals of working age, plus a growing demand for services.

b. Baseline Government Expenditure and Revenue Forecasts

Governmental finances are determined by revenue availability, including many Federal programs, legislation, public demands, political decisions, etc. These are all variant factors which make projections unreliable. Also, it is more germane to this study to compare only estimated revenues associated with the development expenditures rather than estimates of total governmental finances. A comparison of associated revenues and expenditures can be found on Page 361.

c. Personal Income

A comparison of personal income for Lincoln County with and without the proposed ASARCO mine can be found on Page 371.

d. Land Development

Projected population growth within the County will require changes in the existing land uses. Residential, commercial and industrial areas will be required to support population increases. Table III-3 shows population forecasts for Lincoln County without the proposed mine development and the estimated acreages of residential, commercial and industrial land that would be required to support the projected population. Since a county-wide land use survey is not available in sufficient detail to determine per capita land use requirements, land use rates that were quantified for the Libby area by the 1970 land use survey and contained in the Libby Comprehensive Plan, have been used to estimate future land use needs. Although the amount of land that has been developed for various types of land uses in the past may not be the same in the future, residential development and streets, which make up 62 percent of the developed land in the Libby area, will require approximately the same land area in new developments. Industrial development which comprises 19 percent of the developed land in the Libby area may decrease in the future due to expansion of existing industrial sites. Railroads occupy 7 percent of the developed land. There is no foreseeable expansion of railroad facilities in the impact area. The remaining 12 percent of developed land is occupied by commercial, public and semipublic and park uses. Future growth of these uses will probably remain about the same as in the past.

Due to these factors, land use protections based on 1970 use rates will tend to overestimate land area requirements; however, the figures derived are sufficiently accurate to provide a basis for determining if there is land available for future growth within the impact area.

The 1970 Census for the Libby Census Division and the Troy Census Division were used to allocate 1978 and protected population without the mine impact. The Troy and Libby Census Divisions cover areas much larger than the impact area shown in Figure II-18; however; the area surrounding both Troy and LIbby is National Forest land with a limited amount of private ownership. This concentrates the population into areas of private land ownership which are primarily the Towns of Troy and Libby and the surrounding area extending 3 to 4 miles from the city limits. The population estimates shown in Table III-5 represents estimates for the Troy and Libby Census Divisions but can also be considered to be reasonable estimates for the Troy and Libby impact areas.

Table III-5 Land Area Requirements Without Mine Projected Population

Year	Libby Census Division	Troy Census Division[1]	Bull Lake area	Total	Land Required-Acres
1978	10,940	1800	430	13,170	1471
1979	11,000	1805	435	13,240	1479
1980	11,340	1860	450	13,650	1525
1981	11,670	1920	460	14,050	1569
1982	11,670	1920	460	14,050	1569
1983	11,540	1895	455	13,890	1551
1984	11,340	1960	450	13,650	1525
1985	11,400	1880	450	13,730	1534
1990	11,540	1895	455	13,890	1551
1995	11,740	1925	465	14,130	1578

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[1] Excluding the Bull Lake Area as shown in Figure II-18.

In 1970 the Libby Census Division which includes the City of Libby and the surrounding area, contained 66.7 percent of the total county population. The Troy Census Division contained 13.6 percent of the county population. It has been assumed that these percentages will remain constant through 1995 without mine impact.

The 1978 population for the Bull Lake Area has been estimated by using the 1970 census occupancy rate of 3.4 persons per occupied dwelling unit and the 1977 land use inventory conducted by the Lincoln County Planning staff. The 1970 vacancy rate of 11.5 percent was used to adjust total dwelling unit count to occupied dwelling units. Since the Bull Lake area is included in the Troy Census Division, it was necessary to deduct the estimates for the Bull Lake area from the estimates for the Troy Census Division.

Based on normal growth, without the mine impact, land requirements for future development in the impact area range from 8 acres in 1979 to a maximum requirement of 107 acres in 1995. The total land required for future growth amounts to less than 5 percent of the developed land in the Libby area in 1970.

Projected growth within the impact area will not be significant unless it is concentrated in a relatively undeveloped area.

e. Quality of Life and Social Values

In assessing the quality of life in the Troy, Montana area without the development of the ASARCO mine, the overriding consideration in addition to the formulated and inventoried opinions of people in the area, is the overall population increase estimate expected to occur between 1977 and 1995. Estimates place the population growth in Lincoln County at approximately 1,100 persons in the 18-year period between 1977 and 1995. This population increase county-wide would translate to very minimal impact in the Troy area, which is but one of numerous urban concentrations in the county.

Over time, slight changes in the quality of life naturally occur. Because any inhabiting number of people cause specific damage to the aesthetics of an area and since some additional population is projected under the no mine development scenario, a minor deterioration in quality of life as measured by area setting is forecast.

Problems concerning water pollution as related to sewage disposal will have to be dealt with by the people. Assuming these problems are solved, the present water quality should be impacted only very slightly in the foreseeable future. These impacts will very likely be translated into a small decrease in this aspect of the quality of life.

Future jobs are a real concern to the Troy people. They expect the total occupational opportunity scene to diminish in the future unless a new primary employment base can be found. This plus their emphasis on expanding the opportunities for work in the area will equate to a decrease in quality of life.

If there is no mine development and the economic base remains as at present, buying power will very likely deteriorate in the future. With the high percentage of people on retirement and fixed incomes in the area, as inflation takes its toll, the effect of the future of buying power on the quality of life of the residents of the Troy area will be negative.

The current economic opportunities in the area are tied very directly to the natural resource of timber. This local natural resource will become more finite as time goes on and with no substantial increase in economic base in the future, the economic opportunities must necessarily gradually diminish. The resultant effect on the quality of life in the Troy area is negative.

A small community with a beginning balance of a small tax base and a growing number of people on fixed incomes or even unemployment, without significant stimulation in the economic sector will not generate the ability to improve public services. The quality of life as measured by public service assistance is judged to decrease slightly over time without any new economic stimulus.

The isolation factor is projected to increase and is the only factor viewed as increasing the quality of life. This increase in quality can be attributed to the fact that most elements making up the definition of isolation will continue to be in existence in Troy and people generally feel that isolation is positive.

Many factors contributing to the quality of life will not change. However, the few that do are projected to have an overall negative impact on the life style of Troy residents.

f. Social Services and Public Facilities

(1) Housing

Table III-6 shows estimated housing needs for the impact area without the mine impact. The 1970 average dwelling unit occupancy of 3.4 persons has assumed.

Table III-6 shows that there will be a need of 236 additional dwelling units in the Libby area, 37 in the Troy area and 11 in the Bull Lake area by the year 1995. During the years 1983 and 1984 there will be a surplus of up to 118 dwelling units due to a temporary decline in population, however; normal growth will absorb these units by the year 1993.

There is an adequate supply of developable residential property in the three areas of the impact area to meet housing needs of the projected population. Both Libby and Troy have vacant land that could be served by expansion of the utility systems and the Bull Lake area has approximately 7360 acres of developable land.

The addition of 236 dwelling units in the Libby area would require extension of the existing sewer and water systems.

Troy has sufficient privately owned land north and south of the city limits and in the area northeast of the Burlington Northern Railroad tracks within the city limits, to accommodate the 37 dwelling units projected for that area.

The Bull Lake area has sufficient developable land for the 11 dwelling units projected. Utilities would continue to be individual wells and septic system.

Table III-6 Dwelling Unit Requirements Without Mine

	Projected Population[1]			Dwelling Units Required			
Year	Libby Cen. Division	Troy Cen. Division	Bull Lk. area	Libby Cen. Division	Troy Cen. Division	Bull Lk. area	Total Impact area
1978	10,940	1800	430	3217	529	126	3872
1979	11,000	1805	435	3235	531	128	3894
1980	11,340	1860	450	3335	547	132	4014
1981	11,670	1920	460	3432	565	135	4132
1982	11,670	1920	460	3432	565	135	4132
1983	11,540	1895	455	3394	557	134	4085
1984	11,340	1860	450	3335	547	132	4014
1985	11,400	1880	450	3353	553	132	4038
1990	11,540	1895	455	3394	557	134	4085
1995	11,740	1925	465	3453	566	137	4156

[1] Based on 1970 census population distribution and Department of Community Affairs population projections.

(2) Water and Sewage

Improvements to water and sewage systems to serve population growth without the mine impact have been evaluated. This evaluation gives a comparison of improvements that are necessary to meet normal growth demands.

(a) Troy Water System

The Troy water system supply which provides a flow of 1,200 gpm is adequate to supply a population of 2,160 (assuming a peak flow of 800 gal. per capita per day). The 1995 population of the Troy Census Division is estimated to be 1925 persons.

The limiting compoenent of the system is storage and the distribution system. Present storage is a 125,000-gallon tank. This should be doubled to increase reserve during peak periods and to provide the present population with a higher level of service that meets adopted standards[1/] of the State of Montana. The distribution system consists of 6" and 8" lines which are capable of handling additional hookups within the city in the areas where future growth would occur.

[1/] Recommended standards for Water Works, Great Lakes-Upper Mississippi River Board of State Sanitary Engineers 1968.

(b) Bull Lake Area Water Systems

The Bull Lake area has sufficient groundwater to support development from individual wells. The limiting factor will be the density of development that can be served by individual wells and sewage systems before contamination of groundwater supplies occurs.

Based upon the land capability analysis and using the one unit per acre standard, 7360 additional dwelling units could be developed in the Bull Lake area assuming all privately owned land exclusive of large corporate holdings would be developed.

(c) Libby Water System

The Libby water system is supplied by an 80 million gallon reservoir on Flower Creek. This is adequate to meet projected future needs plus expansion of the system to serve outlying areas not presently served. Service of these areas would require construction of new supply lines and extension of the distribution system.

A statewide evaluation of water and sewer systems conducted in 1970 concluded that the Libby water system would be adequate to supply a 1990 population of 11,425 persons. This compares closely to the updated Comprehensive Areawide Water and Sewer Plan, State of Montana 1970 - 1995 projection of 11,740 persons. The only improvement required to serve the additional population would be the addition of distribution piping.

(d) Troy Sewage System

There is presently sufficient vacant land and land occupied by dilapidated structures to provide developable area for individual septic systems to accommodate normal growth projections. As the density of development increases the probability of septic tank failure will increase due to drain field saturation. This will increase the feasibility of construction of a central sewage disposal system. The installation of a central sewage system would allow future higher density development within the Troy city limits.

(e) Bull Lake Area Sewage System

As stated in the section on water systems, the Bull Lake area has adequate vacant land to support projected growth on individual wells and septic systems.

The soils in areas that are likely to be developed in the Bull Lake area are highly permeable and provide good drainage characteristics. The projected growth in the area is 11 additional dwelling units by 1995. Development would most likely continue to be scattered on parcels of land of at least 1 acre. Sewage disposal will continue to be by individual septic systems due to the low density of development

(f) Libby Sewage System

The Libby sewage system has primary treatment capacity to serve 6500 persons. The normal population growth in the Libby Census Division would result in an area population of 11,740 persons by 1995. It would be feasible to serve a population of approximately 6500 persons with the central sewage system by 1995. This estimate was arrived at by combined projected population of the south Libby Flats[1] area and the City of Libby[2]. This is a conservative estimate which assumes extension of service to the entire south Libby Flats area which is not presently feasible due to the low density of development in some areas.

The Federal Water Pollution Control Act Amendment 1972 required secondary treatment by July 1, 1977. The City of Libby will be required to comply with this act by adding secondary treatment facilities. Since the primary treatment facility has adequate capacity to meet future growth projections, the secondary facilities should be sized to the same capacity.

The south Libby Flats area has experienced some groundwater contamination problems and is presently in the process of developing a plan for a centralized system which would tie into the Libby treatment plant.

The other outlying areas could also be served by the Libby treatment plant which would allow higher development densities.

The extension of the sewage system into the areas south and west of the Libby city limits would provide sufficient additional land to meet the projected need of 236 additional dwelling units by the year 1995.

(3) Solid Waste

(a) Troy Census Division including Bull Lake

At the present time this area is served by 56 four hard containers and 4 six yard containers. Based on 1978 population estimates for the Troy Census Division, including Bull Lake, the present level of service provides a collection capacity of .11 cubic yards per capita. Normal growth would require an additional 15 cubic yards of collection capacity. This could be serviced without an increase in collection vehicles.

(b) Libby Census Division

Solid waste collection in the Libby area is by private contractor. No public funds would be required to extend the existing service to meet normal growth demands.

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[1] South Libby Flats Comprehensive Plan, Northwest Planners, Inc. 1974.

[2] Montana Population Projections, 1975-2000, Montana Department of Community Affairs, Division of Research and Information 1977.

(c) Disposal

The Libby landfill has an expected life of from 35 to 40 years based on normal growth.

(4) Schools and Student Transportation

(a) Schools

The forecasted population increase of 960 persons in the impact area by 1995 will include an increase of approximately 260 students.

Schools within the impact area have sufficient capacity to accommodate approximately 1500 additional students.

School expansion will not be necessary to meet projected population needs.

(b) School Transportation

The 1970 population distribution in the County shows that nearly 82 percent of the population was located in rural areas. Assuming that all rural area students would require school transportation, the 1995 transportation needs in the impact area would require a capacity of 221 seats. This would amount to an increase of approximately four school buses, assuming that the existing system is presently operating at capacity.

(5) Recreation

Area recreation facilities would be capable of providing outdoor recreation needs for the normal growth population of 960 persons. The major recreation activities in Lincoln County are outdoor activities such as hunting, fishing, skiing and hiking. The large amount of government owned land in the County assures a continuing supply of open space to accommodate these activities.

Local recreation facilities are located in the communities of Troy and Libby.

Based on land use inventories in the Libby and Troy areas, there are approximately 50 acres of playgrounds, neighborhood parks, playfields and community parks in the Libby and Troy urban areas. Design standards recommend a total of 8.5 acres per 1000 population for these uses. The existing parks are sufficient to serve a population of 5900 persons. The 1995 population in the Troy and Libby city limits is projected to be 4838 persons with normal growth. There is sufficient capacity of the existing local recreation system to meet normal growth demands.

(6) Public Safety

(a) Lincoln County Sheriff Department

The present level of service provided in the County is one sworn officer per 1100 persons. The additional 960 persons forecast for 1995 would require one additional officer. The population growth in the Troy and Bull Lake areas would add 160 persons by 1995. Based on the existing level of service there would not be a need for an additional officer in Troy.

Normal population growth in northern Sanders County would not be sufficient to require additional law enforcement staff in Sanders County.

(b) Other Law Enforcement Agencies

The local law enforcement agencies in Troy and Libby would not require additional staff since the population increase will be distributed throughout the impact area. If the growth was concentrated in one location, there would be a need for at least one additional officer in order to maintain the existing level of service.

(7) Fire Protection

Fire protection throughout Lincoln County is provided by volunteer Fire Departments. Within the impact area, fire protection is provided by urban and rural volunteer Fire Departments.

Libby's fire protection is one of the highest rated in the State. Additional population in the area would contribute additional volunteer personnel.

It would not be necessary to expand the existing Libby and Troy volunteer Fire Departments to meet the needs of an additional 960 persons in the impact area.

(8) Welfare and Social Services

(a) Public Welfare

This Department is presently functioning at or over its capacity. Normal population increases will require additional staff of at least one eligibility technician.

(b) Social Services

Interviews with the present staff indicate that this Department is presently understaffed. Normal population growth will require an increase of one or two social workers and one additional clerical worker by 1995.

(9) Health Services

(a) Health Care

The projected, normal growth increase in the county by 1995 will require two additional physicians to meet the standard physician population ratio of 1.1222 persons.

(b) Hospitals and Ambulances

St. John's Lutheran Hospital in Libby is the only general hospital serving Lincoln County. The Montana State Plan for Hospital and Medical Facilities Construction used the entire county population as the service area population. The 1970 population showed a need for 29 hospital beds to serve Lincoln County. This compares to and existing supply of 34 beds. The present supply of beds is adequate to serve the normal population growth projected to 1995. There is a need for improvement to the hospital including general remodeling, roof replacement and construction of additional off-street parking. These improvements are needed regardless of an increase in population.

The Libby ambulance responds to approximately 250 calls per year and the Troy ambulance to 150 calls per year. The increased population without the mine would require a maximum of 30 additional calls per year. This is well within the capabilities of the existing system.

There will be some improvements required to meet existing needs. The Troy ambulance needs a storage facility for ambulance and equipment. The Libby-Troy ambulance service will need a new ambulance by 1980.

(c) Extended Care Facilities

The Libby Convalescent Care Center provides extended care facilities for persons in Lincoln County. At present, the Center has 63 beds. At the time of the inventory (July 1977) the occupancy was 100 percent. Plans to add 16 more beds are underway.

Based on the present need ratio of 1 bed per 192 persons, the planned expansion will be sufficient to provide for at least 1500 additional persons.

(d) Mental Health Facilities

Increased referrals due to the projected population increases could be handled by the existing operation and staff.

(10) Transportation

(a) Streets and Highways

The projected population for the impact area without the mine is 995 persons (Table III-4 or a total of 294 additional dwelling units by the year 1995. Based upon traffic studies by the Montana Department of Highways, traffic to and from the additional dwelling units in the impact area would amount to 1470 to 2646 trips per day.

The projected volumes are well within the basic capacity of all facilities within the system (Highway Research Board 1965). Noise level projections are presented in Table II-63, Page 276.

The existing street and highway system is in need of some major improvements such as widening and reconstruction as well as minor improvements such as surface repair or replacement. Any increase in traffic will cause further deterioration and will increase maintenance, however.

The most critical section of major highway within the impact area is U. S. Highway 2 between Libby and Troy. Accident rates on this section of highway are high and an increase of local traffic combined with increasing volumes of through traffic due primarily to tourist and recreational travel make this section of highway a high priority for improvement. Plans are presently underway by the Montana Department of Highways to widen and improve this section of Highway.

An increase in the use of forest roads primarily for recreational purposes is anticipated to occur as a result of normal population growth in the area.

(b) Other Travel Modes

The amount of rail, bus and aircraft travel in the County is very limited. Increases of passenger use of these travel modes by an additional 995 persons would not have a noticeable affect and would not require an increase in the capacity of the existing systems.

The existing AMTRAK rail-service has sufficient capacity to meet the transportation needs of the estimated population increase.

Increases in passenger and freight service needs are well within the capacity of the existing bus system.

The Libby airport is capable of handling increased air service should local demands reach a sufficient level to make increased service feasible.

The taxi service in both Libby and Troy would benefit from increased use. The additional population would not generate enough trips to require additional vehicles.

g. Aesthetics

Aesthetic impacts in the area would occur from the development that would take place on both the federal and private lands. The extent and magnitude of these impacts will depend on the land use plans and zoning requirements in effect in the future.

2. Forecasts with Mine Development

a. Employment and Population Projections

The purpose of this section is to provide an indication of the potential employment, income and population effects associated with the proposed ASARCO facility. As is the case with all impact statements of this nature, the projections are largely subjective and as a result subject to considerable uncertainty and debate. Assumptions concerning the following are most critical:

1) the number of nonresidents who will be employed in the mine and

2) the residence of the in-migrants.

b. Employment and Population Effects

The employment and population impacts of the mine were analyzed using the same format that was employed in the baseline projections. These year-by-year projections were made on the basis of the phasing pattern shown in Table III-7. This pattern was formulated after a review of the ASARCO operating plan. The construction and development phase consists of the years 1978 through 1980, with full operation starting in 1981.

Table III-7 Phasing Pattern

	Employment-[1/]	
Year	Construction	Mining
1978	100	10
1979	200	80
1980	20	210
1981	0	310[2/]

[1/] Estimated yearly averages.

[2/] Continued for 15 additional years.

In addition to the phasing pattern the following assumptions concerning migrants and work force residence were made:

1) thirty percent of the construction work force will be made up of local construction workers;

2) fifty percent of the mine work force will be made up of local workers and

3) a) twenty-five percent of the migrants will reside in the Troy area[1/];

   b) forty percent of the migrants will reside in the Bull Lake area[1/] and

   c) thirty-five percent of the migrants will reside in the Libby area[1/].

[1/] For a more precise definition of these areas see Figure II-18.

The assumptions were largely subjective and were based on interviews with representatives of ASARCO, state and local planners and employment specialists in the area.

The basic rationale for the preceding assumptions is relatively straight forward. First of all, it is likely that most construction workers associated with mine development would be in-migrants. Given the accelerated pace of construction activities (i. e., the reregulation dam, the installation of additional hydroelectric generation units, plus the ASARCO project) the local construction work force would in all probability be unable to fully absorb the increased work load. Secondly, given the semi-technical and skilled nature of the work force associated with the operation phase of the mine, it is unlikely that more than half of the new jobs would be filled by current residents. Interviews were held with local employment specialists who largely support this premise. The third assumption which concerns the residence of the in-migrants is considerably more uncertain. Housing in the Troy area is currently either in poor repair or largely unavailable. While the housing situation is much better in Libby, the distance to the mine site would greatly constrain the direct population effect. The third assumption which concerns the residence of the in-migrants is considerably more uncertain. Housing in the Troy area is currently either in poor repair or largely unavailable. While the housing situation is much better in Libby, the distance to the mine site would greatly constrain the direct population effect. The third alternative, the sparsely settled Bull Lake area, would have a significant locational advantage. This area is assumed to absorb the highest proportion of in-migrants either in permanent or temporary structures.

All these assumptions taken together with the previous employment estimates makes the forecast presented in Table III-8 subject to considerable uncertainty. The results, however, seem plausible and represent the best possible projection given the level of general uncertainty.

If one adds the population projections from Table III-9 to the baseline population forecasts presented in Table III-8, a forecast of total population for Lincoln County can be derived that includes the effects of ASARCO mining activity. This forecast along with the baseline projection is shown in Table III-8.

Table III-8 Population Forecast Comparison[1] Lincoln County

Year	Without Mine	With Mine	Percent Increase
1978	16,400	16,600	1 percent
1979	16,500	17,100	4 percent
1980	17,000	17,700	4 percent
1981	17,500	18,500	6 percent
1982	17,500	18,500	6 percent
1983	17,300	18,300	6 percent
1984	17,000	18,000	6 percent
1985	17,100	18,100	6 percent
1990	17,300	18,300	6 percent
1996	17,600	18,600	6 percent

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[1] Forecasts are to the nearest 100 persons to avoid spurious accuracy.

Table III-9 Projected Population Associated with the ASARCO Mine by Area 1977-1978[1]

Year	Troy area	Libby area	Bull Lake area	Total
1977	0	0	0	0
1978	50	70	80	190[2]
1979	150	200	230	580
1980	180	250	290	710[2]
1981	250	350	400	1000
1982	250	350	400	1000
1983	250	350	400	1000
1984	250	350	400	1000
1985	250	350	400	1000
1990	250	350	400	1000
1996	250	350	400	1000

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[1] Projections are rounded to the nearest 10 persons.
[2] Total does not add due to rounding.

Example of computation for Table III-9:

$$1978^{1} = (100^{2} \text{ X } .7^{3} \text{ X } 2.28^{4}) + (10^{5} \text{ x } .5^{6} \text{ X } 2.313^{7} \text{ X } 2.82^{8}) = 190$$

[1] Total Population.
[2] Construction Employment.
[3] Proportion in-migrants.
[4] Average Family Size.
[5] Mining Employment.
[6] Proportion in-migrants.
[7] Permanent Employment Multiplier*.
[8] Population Multiplier.

*This multiplier is defined as 1 plus the nonbasic multiplier used earlier, in order to estimate total permanent employment in one step.

The assumed percentage distribution of new residents for the Troy, Libby and Bull Lake areas (25, 35 and 40 percent) was then applied to the total to obtain the individual area breakdowns. In addition for the Troy and Libby areas, it is likely that most in-migrants will live outside the present city limits. Also, it was assumed that new residents will live in only these three areas of Lincoln County.

c. Government Revenue and Expenditure Impacts

The analysis of fiscal impacts of the proposed ASARCO development is presented in this section. The approach will be both quantitative and qualitative. Quantitative estimates of state and local tax receipts associated with the mine will be made. On the other hand, the extra public expenditures needed because of the ASARCO project are extremely difficult to project, partly because per capita public service costs change as population changes. In addition, expenditure levels are also political decisions which are not subject to prediction. Therefore, the expenditure side of fiscal impact will emphasize a qualitative assessment of existing public services and facilities and a judgment as to additional expenditures required by the ASARCO development. The last step in the analysis will be an overall conclusion on whether or not revenues generated by the mine will offset additional expenditures.

(1) Revenues

There are five major sources of revenue resulting directly from taxation of the ASARCO development. These sources are as follows: Property Tax, Gross Proceeds Tax, Resource Indemnity Trust Tax, Metalliferous Mines License Tax and Corporation License Tax. The first two are earmarked for use primarily by local governments and are collected by the county treasurer. The others are collected by the State Department of Revenue for statewide purposes. Each tax is described in detail below, along with other sources of revenue for governments operating in Lincoln County.

(2) Property and Gross Proceeds Taxes

The facilities including equipment and land of the ASARCO project would be subject to a property tax levied by Lincoln County. The proceeds primarily would help fund the Troy school district and Lincoln County. The gross proceeds tax is in effect a property tax on a mineral resource. It would be based on the dollar value of the ore extracted from the ASARCO mine in any given year. The effects of the mine on both types of property taxes will be collectively discussed below after the methods used to estimate each have been presented.

(a) Property Tax Revenue

The estimation of property taxes associated with the ASARCO development was based largely on projections formulated by the Comptroller's Department of ASARCO, Inc. These in turn were based on capital expenditures anticipated by ASARCO, a 6 percent straight-line yearly depreciation rate, a partial tax reduction associated with the State "Industrial Development Tax Incentive Program" and a mill level of 187.522. The last two items need additional explanation.

The "Industrial Development Tax Incentive Program"* is so new that specific guidelines for its implementation have not been formulated. However, it appears that the ASARCO development may qualify for the program's 77 percent property tax reduction in the first three years of mine operation. At the same time, it should be pointed out that the Montana Department of Revenue will make the final determination as to the facility's eligibility for the program. In addition, a plant is ineligible if it creates a substantial adverse impact on government services, although what constitutes a substantial impact has not yet been defined. In the impact case, prepayment of property taxes may be required. It is also possible to have a situation where both the prepayment of taxes and the tax reduction program apply.

The mill levy of 187.522 used by ASARCO in its projections appears to have erroneously included recent levies for the municipalities of Troy and Libby. A more accurate figure to use in projecting tax revenue is the average levy for Fiscal 1976 of 145.46. This figure excluded mill levies for Troy and Libby which are not relevant for a facility located outside their city limits.

Revised property tax projections were made using a levy of 150 mills and for alternatives of with and without the "Industrial Development Tax Incentive Program". A levy of 150 mills was used to reflect a probable increase in the average county mill level based in part on county budget figures for Fiscal Year 1978. Alternative forecasts were prepared because of the uncertainty as to eligibility of the ASARCO project for the tax incentive program. Table III-10 presents property tax projections assuming that ASARCO is judged ineligible for the "Industrial Development Tax Incentive Program" while Table III-11 incorporated this program.

(b) Gross Proceeds Tax

As mentioned above, the gross proceeds tax is a property tax on an extracted mineral resource based on the dollar value of the ore, which in a particular year is dependent on the price of the minerals extracted and the volume of production. Price is the most volatile of these two factors and is very difficult to predict.

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*Revised Codes of Montana 1947, Volume 5, Part 2, 1977 Cumulative Supplement, Section 84.301.19 and Section 84.41.105.

Table II-10 Property Tax Projections Without Tax Incentive Program (1977 Dollars)

Year	Taxable Valuation[a]	Percent of FY 1978 County Taxable Valuation[b]	Amount of Tax
1978	$ 786,000	4	$ 118,000
1979	5,165,000	25	775,000
1980	7,186,000	34	1,078,000
1981[c]	7,188,000	34	1,078,000

Source: Unpublished estimates submitted by the ASARCO, Inc., recalculated using a levy of 150 mills.

[a] Taxable Valuation is 12 percent of market value.

[b] Fiscal 1978 County Taxable Valuation is $20,969,056.

[c] Projections are assumed to continue at the 1981 level through 1996. Actual yearly Taxable Valuation may be more or less than this figure, depending on the changing market value for the facility.

Table III-11 Property Tax With Tax Incentive Program (1977 Dollars)

Year	Taxable Valuation[a]	Percent of FY 1978 County Taxable Valuation	Amount of Tax
1978	$ 183,000	1	$ 28,000
1979	1,205,000	6	181,000
1980	1,677,000	9	252,000
1981[b]	7,188,000	34	1,078,000

Source: Derived from data submitted by ASARCO, Inc.

[a] Taxable Valuation is 2.8 percent of market value for the first three years of operation under the "Industrial Development Tax Incentive Program".

[b] Projections assumed to continue more or less at the 1981 level through 1996.

Table III-11 Gross Proceeds Tax Projections (1977 Dollars)

Year	Taxable Valuation[a]	Percent of FY 1978 County Taxable Valuation	Amount of Tax
1978	$ 0	0	$ 0
1979	0	0	0
1980	736,000	4	110,000
1981[b]	1,355,000	6	203,000

Source: Derived from estimates submitted by ASARCO, Inc.

[a] Three percent of the market value of minerals extracted.

[b] Projections continue at the 1981 level through 1996, assuming a constant rate of production.

In the projection of gross proceeds tax revenue, ASARCO, Inc. appears to have used prices for copper and silver that closely approximated 1976 yearly averages of $ .70/lb. and $4.35/oz. respectively. These projections were adjusted to a 150 mill levy as in the case of regular property taxes. The revised projections are presented in Table III-11.

Two general comments concerning the format of Tables III-9, III-10 and III-11 are in order. First, for an analysis of the revenue impact of the ASARCO project, the percent of FY 1978 County Taxable Valuation is the most relevant column in these tables. On the other hand, the amount of tax is the least important since it depends on the mill levy. Tax proceeds numbers were included only to provide some idea of the magnitude of tax revenue if the ASARCO property were taxed at a level of 150 mills.

An inspection of these Tables yields the conclusion that by 1981, assuming no additional increase in county Taxable valuation, the ASARCO development would increase Lincoln County property valuation by about 40 percent. This is rather a substantial increase. The increase before 1981 depends on the question of eligibility of the project for the "Industrial Development Tax Incentive Program". For example, in 1980 the project would cause an increase in taxable valuation of 12 percent with the tax incentive program and 40 percent without. In general, it can be concluded that large increases in property taxable valuation would result from the project.

(3) Resource Indemnity Trust Tax

The Resource Indemnity Trust Tax is levied annually on all mining activity in Montana. The tax rate is $25.00 plus one-half of 1 percent of the gross value of production in excess of $5,000. Thus, this tax is like the Gross Proceeds Tax discussed above in that it depends on the market price of the mineral extracted. The tax receipts are deposited in the State Resource Indemnity Trust Account of the Trust and Legacy Fund. Monies in this trust account are invested by the State Board of Investments.

The purpose of the fund is to make money available to improve the total environment and rectify damage caused by mining operations. The fund and investment earnings remain intact until their total reaches $10 million. At this level, the investment earnings can be expended for the purpose mentioned above. Once additional tax receipts expand the fund to $100 million, both the investment earnings and any additional tax receipts can be expended to rectify environmental damage caused by mining.

Using the same mineral prices as for the Gross Proceeds Tax, ASARCO, Inc. estimated the Resource Indemnity Trust Tax at $122,000 for 1980, and at $225,000 for 1981 and thereafter through the project lifetime, assuming a constant rate of production after 1981.

This tax will not necessarily benefit Lincoln County. However, it may be utilized should environmental damage occur that is caused by the mine operation and is not satisfactorily corrected by ASARCO.

(4) Metalliferous Mines License Tax

The Metalliferous Mines License Tax is collected by the Department of Revenue for the State of Montana. This tax also is based on the gross value of annual production and is levied on a graduated basis, increasing as the gross value of production increases. Projections supplied by ASARCO, Inc. estimate the tax at $348,000 for 1980, and $643,000 for 1981 and thereafter. Assumptions of constant mineral price and rate of production used for other tax projections apply to these estimates as well.

(5) Corporation License Tax

Similar to the Metalliferous Mines License Tax, the Corporation License Tax is levied by the State of Montana. The license fee is measured by the corporation's annual net income derived from or attributable to, Montana sources. Thus, it is really a corporate income tax. The rate is 6.75 percent of net income with a minimum payment set at $50.00 ASARCO crudely estimated that the tax payment associated with the mine would be $55,000 per year. This figure would only apply to years of full mine operation, i. e., 1981 and beyond.

(6) Other Revenue Source

There are two types of other sources of state and local government revenue that would be associated with the ASARCO project: extra revenue from taxes and fees paid by the increased population, and intergovernmental transfers from the federal government. The extra tax revenue would come from the following specific sources: property taxes on new houses, personal property taxes, personal income taxes, motor vehicle license fees, driver's license fees, etc. Funds from the federal government would be provided through revenue sharing, and various grant programs including school impact aid.

This latter program provides federal dollars to a local school district to partly cover expenses of workers' children associated with projects on tax exempt federal land. Part of the ASARCO mine would be located on U. S. Forest Service land.* Because of data limitations and other uncertainties, a projection of other government revenue generated by the ASARCO project was not attempted.

(7) Expenditures

As was stated previously, expenditures for public services necessitated by the ASARCO development cannot be accurately quantified, but a qualitative assessment can be made by reviewing the existing public service capacities and projected deficiencies. These were outlined in Chapter II, Section C-5 and Chapter III, Section C-3.

Most identified or projected local public service deficiencies appear to be of an operational nature, e. g., personnel. No major capital expenditures were listed with the exception of Yaak Avenue in Troy. Thus, many government agencies would be required to expand their operating budgets as the result of the ASARCO project, but would not have to build new facilities or substantially remodel existing ones.

(8) Overall Assessment of Revenues and Expenditures

This subsection contains a qualitative assessment of the net fiscal effect of the ASARCO project on Lincoln County government bodies. These are: Lincoln County, the municipalities of Troy and Libby, and the Troy and Libby School Districts.

(a) Lincoln County

County revenues associated with the ASARCO development should exceed additional expenditures. The increase in the tax base is substantial and should more than offset any operating budget impact. In fact, it is plausible that a decrease in the county mill levy would eventually result. This was the case for Big Horn and Rosebud counties, Montana which experienced mining-related developments similar to the ASARCO project.*

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*The Troy school district presently receives $291,000 per student under this program for other federal impact projects (E.g., logging on Forest Service land).

(b) Municipalities

The existing municipalities (Libby and Troy) are projected to bear the brunt of the population influx. It was estimated that 25 percent of new residents would settle in the Troy area and 35 percent in the Libby area for a total of 60 percent. For various reasons, it was assumed that the majority of these new residents would locate outside the present corporate boundaries of Libby and Troy. However, these residents, although living outside the city limits, do impact the municipality's public services. A good example would be city streets which experience increased usage from a buildup of the surrounding suburban population. Yet, the benefit of property taxation of the suburban residents is not available to the municipality to offset expenditures caused by increased traffic.

Of all the local government entities in Lincoln County, it is likely the communities of Libby and Troy will experience the greatest expenditure impact with the least offsetting direct revenues. This judgment is based on two factors, namely the indirect population phenomenon discussed above and the fact that neither municipality will receive any property tax revenue from the ASARCO facility.

(c) School Districts

The school districts expected to be affected by the proposed development are: Troy High School District 1 and Elementary School District 1, and Libby High School District 4 and Elementary School District 4. A survey of the facilities and classroom capacities in these districts was given in Chapter II, Section C-6. Based on an estimate of the number of school-age children associated with increased population due to the ASARCO development, it is anticipated that existing facilities can accommodate these children. Teachers are the only projected deficiency. Before a judgment on the fiscal impact for the affected school districts can be made, a review of the funding scheme for school districts is necessary. This review will include the General Fund and numerous special funds.

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*Office of the Montana Legislative Fiscal Analyst "Coal Impact and Coal Board Grants" unpublished report to the Legislative Finance Committee, September 20, 1977.

The general Fund for Montana's school districts is derived in a rather complex fashion. Sources of funding normally include the state, county and the districts themselves. State funds are provided only to those districts that are unable to generate sufficient funds from their county and district sources. This funding concept is depicted in Table III-12.

The Maximum General Fund Budget is set each year by Montana statutes. Eighty percent of the budget (Foundation Program) is financed by the county and state. The county's contribution is mandated at 40 mills levied against the total county property taxable valuation, but if the county's contribution does not meet the total Foundation Program amount, the state will satisfy the deficiency. However, if the county's contribution exceeds the budgeted amount, the surplus reverts to the state equalization fund to be allocated to other counties where a deficiency exists. With Lincoln County's increased tax base due to the ASARCO property, such a surplus is likely.

The remaining 20 percent of the Maximum General Fund Budget is supplied by the School District and the State Permissive Levy. The elementary districts must levy up to 9 mills and the high school districts up to 6 mills before any state funds can be received. The district levies generate funds based on property valuation within their district boundaries. Therefore, the ASARCO mining property will benefit only the Troy school districts. In this case, surpluses due to the district levies do not revert to the state and as a result, districts will levy only an amount sufficient to reach 20 percent of the Maximum General Fund Budget, up to the maximum allowed millage, i. e., 9 mills for an elementary district and 6 mills for a high school district. Thus, it is probable that Troy's two school districts can levy less than the maximum millage under this stipulation. Libby's school districts will probably still require the maximum allowed mill levies. Any deficiencies will be satisfied by the State Permissive Levy.

However, it should be explained that the State Permissive Levy is set by an assessment of the expected cumulative deficiencies for all of Montana's counties. Then a uniform county levy is established based on the sum of all the counties' property valuations that will satisfy this deficiency. Thus, Lincoln County must levy against this requirement even though not all their districts have a deficiency which requires utilization of the State Permissive Levy.

Beyond the Maximum General Fund Budget ceiling, additional costs for operation and maintenance are supplied solely by the district levy and must be approved by a public vote. This additional funding has been required by the Lincoln County school districts in recent years. Table III-13 reflects the percentage of the total district general fund that was budgeted from this source for the two most recent school years.

Table III-12 Financing a School District General Fund Budget* in Montana

TOTAL GENERAL FUND BUDGET*	DISTRICT	DISTRICT VOTED LEVY Amount Approved by the voters to meet Total Budget Requirements
MAXIMUM GENERAL FUND BUDGET This amount is set by statute based on an enrollment formula plus approved Special Education costs.	STATE	STATE PERMISSIVE LEVY
	DISTRICT	DISTRICT PERMISSIVE LEVY 9 mills Maximum - Elementary 6 mills Maximum - High School
FOUNDATION PROGRAM 80 percent of Maximum General Fund Budget	STATE	ADDITIONAL STATE LEVY FOR STATE DEFICIENCY If the mandatory county levy and state equalization aid amounts do not fully fund the foundation program
	STATE	STATE EQUALIZATION AID Earmarked Revenue, Legislative Appropriation, Interest and Income and Surplus from Counties.
	COUNTY	MANDATORY COUNTY LEVY 25 mills - Elementary 15 mills - High School

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*The district's General Fund Budget provides for maintenance and operational costs. It accounts for the greatest majority of the total district costs. Not included in the General Fund are separate budgets for Retirement, Transportation, Debt Seryice, etc., as established by law.

Source: Office of the Superintendent of Public Instruction, Helena, Montana 59601.

Table III-13 Percentage of Total District General Fund Budgeted from the District Voted Levy for Lincoln County

	TROY		LIBBY	
School Year	H. S. District 1	E. S. District 1	H. S. District 1	E. S. District 4
1976-1977	12 %	15 %	18 %	15 %
1977-1978	9 %	9 %	17 %	19 %

Source: Unpublished reports and budgets submitted to Finance, Planning and Evaluation Services, Office of the Superintendent of Public Instruction, Helena, Montana 59601.

The ASARCO development will probably cause the percentages in Table III-13 to slightly increase because of higher operational costs due to greater enrollment. However, the greater tax base in Troy's school districts will enable any increase in operational costs to be satisfied without raising the mill levy. In fact, the mill levy can probably be reduced and still provide sufficient funding for the cost increase. Thus, Troy's District Voted Levy for Elementary School District 1 and High School District 1 should eventually decrease.

This will not be the case for the Libby school districts (High School and Elementary School District 4). There will not be the significant tax base increase that can be levied against, to offset higher operational costs. Thus a slight increase in the District Voted Levy is anticipated for these two districts. However, some compensating funds will come from the federal school impact aid program for the projected enrollment increase as previously discussed.

The above discussion considered only the District General Fund. Separate budgets must be established for Retirement, Transportation, Debt Service (Bond Retirement), etc. These special fund budgets have historically represented a much smaller portion of the total district expenditures than the General Fund. For the four Lincoln County school districts this portion has ranged from 17 to 30 percent of the total district expenditures for the past two completed school years. The source of these special budget funds is primarily the county and the individual district property levies, although for these two years a significant amount was provided by miscellaneous federal funding programs. Through a similar analysis to that used above, it is concluded that the ASARCO property will benefit the county and Troy's two school district funding capabilities with a likely reduction in the required mill levy. Libby on the other hand, may require a slight increase in the mill levy to meet additional budget requirements because of higher enrollment.

Thus, a judgmental conclusion of the impact on school district funding is: 1) Lincoln County and Troy's High School District 1 and Elementary School District 1 should benefit through reduced mill levies, 2) Libby's High School District 4 and Elementary School District 4 should experience a slight increase in the mill levies and 3) the school districts throughout the state will benefit as a result of state equalization funding procedures.

d. Personal Income Effects

This section discusses the nature of the effects of the proposed ASARCO project on average income for Lincoln County. The method used to approximate the effects was to superimpose the ASARCO mine on the 1975 economy of Lincoln County and then to compare known 1975 income levels with simulated levels that included ASARCO. The employment and payroll levels for the most typical year of mine operation were used in this simulation. In general, this section describes the general order of magnitude of the income effects, but does not attempt to predict the magnitude of income changes in the specific years in which the mine is proposed to be operating.

Three different income measures for Lincoln County in 1975 are presented in Table III-14. These were computed using earnings and employment data supplied by the Bureau of Economic Analysis, U.S. Department of Commerce. Average Wage and Salary Employee Earnings are higher than Average Employee Earnings because the latter measure includes proprietors who earned about half as much as wage and salary workers in 1975. The last item in Table III-14 represents average income for wage and salary workers, excluding fringe benefits paid for by the employer.

Table III-14 1975 Average Income Measures for Lincoln County

Average Employee Earnings[1]	$ 9,960
Average Wage and Salary Employee Earnings[2]	11,010
Average Wages and Salaries[3]	10,390

Source: Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C. - unpublished data.

[1] Includes proprietors. Earnings differ from Personal Income by including personal contributions for social insurance programs (e.g., Social Security), and by excluding property income (e.g., dividends) and transfer payments (e.g., veterans benefits). Both earnings and personal income include fringe benefit items.

[2] Excludes proprietors and their earnings.

[3] Excludes fringe benefits for wage and salary workers.

Average income figures for the ASARCO project are shown in Table III-15. Included in Table III-15 are earnings with and without the planned administrative staff and with and without the fringe benefits included in data of the previous table. Earnings were computed without the ASARCO administrative staff in order to eliminate a possible distortion in average income caused by a small number of top level managers and professionals. As can be seen from Table III-15, the averages did not change substantially with this adjustment partly because the administrative staff includes clerks and engineers' helpers in addition to managerial and professional persons. Average Wages and Salaries for all ASARCO personnel exceed the average 1975 Lincoln County level by about $1,500. However, this gap is overstated, since data used to compute the Lincoln County figures included part-time workers and ASARCO data did not.

Table III-15

Average Income Levels for ASARCO Personnel (1975 Dollars)

Average Wage and Salary Employee Earnings	$15,800
Average Earnings, Without Administrative Staff[1]	15,490
Average Wages and Salaries[2]	11,920
Average Wages and Salaries[2], Without Administrative Staff	11,690

Source: "Troy Project Wage Rates - June 1, 1975", provided by the ASARCO Project Coordinator.

[1] ASARCO classifies 62 persons as administrative.

[2] Excludes fringe benefits.

On the other hand, Average Wage and Salary Employee Earnings for ASARCO exceed the Lincoln County Figure by almost $4,800, primarily because of an estimated fringe benefit program for ASARCO employees that is much better than the 1975 average program for Lincoln County employees.

In order to assess the impact of the mine on Lincoln County income, the payroll and employment of the mine were superimposed on the 1975 economy by estimating the extra employment and earnings, both directly and indirectly*, the mine would add. This estimate was computed by taking a typical mine employment level of 310 persons plus an associated payroll, including fringe benefits, of $4,897,674 (1975 dollars) times appropriate employment and earnings multipliers.* The result was extra total employment of 655 persons and earnings of $6,886,315. These then were added to actual 1975 figures for Lincoln County, and resulted in an increase of about 13 percent for earnings and 11 percent for employment. This simulation also resulted in average employee earnings increasing by two percent. Table III-16 summarizes the results of the simulation.

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* The indirect effect is the increase in non-basic (service) activity. The direct effect is the extra employment and earnings of the mine itself.

Table III-16 Simulated Earnings and Employment for Lincoln County With and Without the Mine - 1975

	Without Mine	With Mine	% Change
Earnings[1]	$ 60,586,000	$ 68,520,232	13
Employment	6,080	6,735	11
Average Employee Earnings	$ 9,965	$ 10,174	2

Source: Derived From unpublished data of the Bureau of Economic Analysis, U.S. Department of Commerce, and from data supplied by ASARCO, Inc.

[1] Includes proprietors income and fringe benefits.

e. Timber Production Loss

Approval of the ASARCO project will necessitate disturbance of some 610 acres of timber production land, which will postpone the growth and eventual maturity of the timber for the life of the mining project, estimated to be 19 years. Since merchantable timber is an essential economic resource to Lincoln County, this postponement represents an economic loss over the life of the mine.

An estimate of this loss at present market prices can be made. Of the 610 acres in question, about 450 acres belong to the St. Regis Paper Company and 150 acres belong to the United States Forest Service (USFS). Upon request, the USFS has supplied average timber production and their average timber price figures for this land area. It was also estimated that the time of growth from planting to the saw timber stage is 80 years in this area. Finally, the average wholesale value for timber production in Montana during 1976 calculated by the Western Wood Products Association, Portland, Oregon, was used to approximate the wholesale market value of the timber in current dollars.

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* The 1975 employment and earnings multipliers used were 2.11 and 1.62 respectively.

Since the mining lifetime represents about 24 percent of the growth cycle of the timber stand, only this percentage of its wholesale value is counted as an economic loss. Then the 610 acre production postponement for 19 years represents a loss of about $412,000 in terms of the 1976 average wholesale price.

However, there is one additional timber loss that will be incurred with the mine development. St. Regis clearcut and reseeded 300 acres in 1968. Their investment in this effort was about $12,000. Additionally, this acreage now has about a 10 year growth that will be completely destroyed by the mine development. Using calculations like those above, this 10 year growth loss is estimated to be $106,000. Thus, the total value of the resource loss is estimated at $530,000.

It could be inferred that in addition to the resource loss, there would be some indirect losses such as a forfeiture of income and possibly jobs in the local wood processing industry. However, this probably would be an inaccurate conclusion since there should be available timber elsewhere to maintain production capacity at market demand and thus it's unlikely that the wood processing industry would suffer from this minor timber loss.

A better perspective of the timber production loss can be seen in light of the economic benefits from the mine development. The estimated $530,000 loss over a 19 year period is relatively insignificant when compared to an appraised market value for mineral production of about $45 million annually.

f. Land Development

Projected population associated with ASARCO Mine by area shown shown in Table III-9 were combined with Table II-6 which shows population growth projections without the mine to arrive at the population projections shown in Table III-17.

As previously stated, these estimates assume that the percentage of county population residing in the Libby and Troy Census Divisions will continue to remain the same as it was in 1970.

Table III-17 shows that there would be a land acre requirement of 196 acres by 1995 to meet the needs of normal growth plus the mine impact population increase. Normal growth would require an increase of 107 acres by 1995.

Table III-17

LAND AREA REQUIREMENTS WITH MINE

Year	Projected Population Libby Census Division	Troy Census Division[1]	Bull Lake Area	Total	(Land Required)[2] (Acres) Without Mine[3]	With Mine
1978	10,990	1870	510	13,370	1471	1494
1979	11,150	2005	665	13,820	1479	1544
1980	11,520	2110	740	14,370	1525	1605
1981	11,920	2270	860	15,050	1569	1681
1982	11,920	2270	860	15,050	1569	1681
1983	11,790	2245	855	14,890	1551	1663
1984	11,590	2210	850	14,650	1525	1636
1985	11,650	2230	850	14,730	1534	1645
1990	11,790	2245	855	14,890	1551	1663
1995	11,990	2275	865	15,130	1578	1690

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[1] Excluding the Bull Lake Area as shown in Figure II-18

[2] Based on 1970 Land Use Requirements for the Libby Planning Agea. Libby Comprehensive Planning Program, Phase 1, 1971.

[3] Table III-5

Impact area land requirements increase from 1978 to 1982, at such time, population decreases due to completion of construction on the reregulation dam and installation of additional hydroelectric generation units, there would be a population decrease. The number of new residents associated with the ASARCO mine would not be sufficient to off-set the outmigration of construction population on the other projects in the area.

Residential and commercial acreages are most likely to expand to meet the needs of the influx of mine construction workers, since these uses are required to meet the immediate needs of the impact population. Typically, service industries such as laundromats, beauty and barber shops restaurants, bars and similar industries, expand with the initial impact.

Industrial and public/semi-public uses are most stable and expansion usually is due to normal population growth rather than impact growth. In the case of the mine impact, the construction and operation of the mine will be the primary industrial employment. Due to the time required to expand public and semi-public facilities such as schools, playgrounds, parks, churches, and city and county buildings, the expansion of these facilities would be over a longer time span unless immediate needs of the impact population create a crises situation that requires emergency action.

g. Quality of Life and Social Values

Since the projected work force and related population impacts of the development and operational phases of the proposed mine intermesh closely, this section will deal with the anticipated local effects on area quality of life for the development and operational phases together. Some very slight differences would exist in these quality of life categories for development as compared to operation. The development phase would have a higher percentage of temporary, outside worker impacts. The long operational phase would, of course, be the phase that would directly affect the Troy residents. The duration of impact is the important reason. Influences, however, from each of these phases are nearly identical, thus the comments and study findings are here considered as one.

Projected employment levels and associated population levels accorded to the development of the ASARCO mine have been discussed previously.

An important factor that must also be considered along with the projected population in the county is the assumed percentage distribution of new residents for the Troy area, the Libby area and the Bull Lake area. Calculated and judgmental assessments have placed the percentage breakdown of new residents at 25 percent residing in the Troy vicinity, 35 percent in the Libby area and 40 percent near the region known as Bull Lake. The assessment of quality of life in the Troy region includes those people living between Bull Lake and Troy.

In 1978, the incoming population estimate for Troy and Bull Lake combined is a total of 130 people. This gradually expands to the year 1981 when a total of 650 new people in the region is anticipated. This breaks down to a total of 400 residing in the Bull Lake area and 250 in the Troy area. The population influx associated with the ASARCO mine is anticipated to remain at that level until 1995 or through the entire operational phase and planning period being addressed in this analysis.

Relatively, the impact of these numbers of people falls more heavily on the Bull Lake area than it does on the Troy area. That is true since the Bull Lake area has no concentrated community or town such as Troy. Troy has an organizational framework that can more easily accommodate growth than can a rural rea such as Bull Lake.

Considering the present conditions in and around Troy, and the attitudes of the people in the area, a negative impact on the area setting will result from mine development. Unavoidable pressures would be exerted on a genreal area's natural beauty. Because the residents highly value the forested mountains, seclusion, quiet lakes and streams, any type of intensive development would potentially impact this value. The increase in population would make lakes and rivers in the immediate area more crowded. Also increased activity in the area and at the mine could cause stream quality degradation without proper regulation. The mine development would make it necessary for more housing to be made available. Housing needs and trailer courts would make it necessary to develop additional land around the Bull Lake area and the Troy area.

The lifestyle of the residents is likely to change; with more activity going on, the pace would pick up. Lifestyles will change considering the different types of people the employment at the mine would foster. Present residents would likely be somewhat defensive of that change; the net result in terms of quality of life will be a decrease.

With mine development, the population of the Troy area would increase as would all of the variables dependent upon population for change. While the small towness woul be impacted, the community would continue to be regarded as a small town.

The general atmosphere in the community would very likely remain rooted in an individualistic attitude and an independency that is manifest in most every action of people in the community. As indicated in the discussions and surveys with people in the area, one of the primary factors that affects local attitudes presently is the uncertainty of the future economic base and the future ability of the community to support those people who are there now, and those people who might wish to come there in small numbers in the future. The introduction into the community of a primary economic base such as the ASARCO mine would result in a substantial increase in the local economy and would do much to alleviate some of the uncertainty about the future. Because of the significance of the economy on attitudes, the net effect of the introduction of the mine into the community would be a slight but positive increase in quality of life as measured by local attitudes.

With an early construction employment of approximately 100 employees increasing to 200, and an eventual mining employment of over 300 employees, the impact upon the Troy area in regard to backgrounds of the inhabitants would be significantly impacted with the development of the mine. The people who would migrate into the area for work would, for the most part, not bring with them any personal attachment to the area that is now certainly a part of those who live in the region. This attachment and feeling for the area would likely grow among those who migrate in; however, it probably will never be at the level now observable to a visitor to the Troy area.

Primarily the in-migrating worker would be viewed as a newcomer. On the whole, the employees would be younger, not rooted in the area, and probably not steeped in the land ethic like many of the people who now reside in Troy.

It is anticipated that even through there would be a sincere attempt by the contractors and mining operators to hire local individuals, for the reasons of inability or non-interest, a significant number of locals may not work at either the construction site or the operational mine. For this reason, much of the impact anticipated for the area under mine development would be attributable to outside individuals. In the measurement of the local quality of life as seen by the present local residents, this would be a very substantial negative impact resulting from mine operations. There would, however, be a positive effect on the employment picture, as any opportunity for new or more jobs is considered very important to the Troy residents.

As the population base of the area increases as a result of in-migrating workers, several noticeable effects would likely occur in the category of buying power. Initially, with relatively high wages being paid the construction workers and the mine workers, there would be an increased ability of the local population on the whole to purchase goods and services. At the same time there would be a concurrent increase in the offering of goods and services that are attracted by the increased population and the new disposable personal income. This increased opportunity for retail activity will result in an expanded retail base from those presently in the area, and will attract new retail operations now not present.

Some of the goods and services now purchased by local residents outside of the Troy area would very likely then be purchased locally. The present resident of the Troy region would view this increased opportunity for local buying in a positive manner.

With the reintroduction of mining activity to the region and the associated spin-off development activity, an improvement in public services, at least from a financial standpoint would be enhanced. The opportunity for improving certain public services, such as education and especially health services, is an offsetting factor for most people in Troy. With the ASARCO corporation as a contributor, followed by the new residents and their real estate, plus the additional business activity, the general resident of the region views the expanded tax base as the means to accommodate the increased demand for public services.

The Troy people presently do not have a high regard for a heavy amount of organizational control. As discussed earlier, the local governmental operations are not viewed as overpowering by the local people, and the informal organizations exercising control are also viewed as not overpowering. The quality of life is enhanced by a reduced or a low level of general organizational control in the community. With mining activity taking place and the additional planning and local pressures on governmental agencies, local, state and federal, there necessarily would be an increase in controls exerted upon the local community by formal organizations. This is recognized and viewed as a negative result of the mining activity.

With the population base expected to change by nearly 650 people in the immediate Troy area and Bull Lake region, the variable termed mobility of residents would significantly change. The newcomers to the region attracted there by the mining activity, both construction phase and operational phase, would be much more mobile than the permanent residents of Troy. In addition to that basic mobility inherently a part of the newcomer, the opportunity for increased movement and increased transportation would be a part of the development of the mine in the area.

Considering that no other industry is introduced to the area those people moving out of the area, following completion of the project, would leave behind excess housing and vacant sites such as trailer spaces. The area setting would likely be impacted adversely at phase out, then gradually improve.

During the post operational phase, less activity in the area would mean less crowded lakes and streams for sports and recreation. Local sportsmen would experience less competition in hunting and fishing, and favorite areas would be more available. The parks and other facilities would remain, resulting in a general increase quality of life.

If the primary economic base, that of mining activity, is ended abruptly and in the process no other broadening of the local economy has taken place, then impacts on the quality of life would be very substantial in terms of the local residents' attitudes. The economy would have gone through the boom cycle and would be in a bust situation. That would have a depressing and negative impact upon the local attitudinal atmosphere of the people then residing in the Troy area.

Generally public services would experience a decline following completion of the mining activity. The tax base would be gradually diminished as operational activity slows and as people leave the area. The educational system would have fewer people to educate and fewer dollars to support their facilities. Health services would likely decrease as a result of the population base diminishing. In general there will be an attendant decrease in need for public services as well as a decrease in the ability to fund public services.

Employment opportunities would, of course, decrease with the closing of the mine. The area would again be forced to rely on one industry (lumber) for employment, assuming no other industry was developed during the life of the mine. Welfare and unemployment would likely increase again, and young people would be forced out of the area in search of employment.

At the completion of the operational phase of the mine and the movement out of the area of many of the workers, the buying power previously manifested in the area would diminish. In addition, those opportunities for purchase of goods and serices would likely diminish as the population base and the disposable personal income would not remain to support previously established business.

Considering all elements studied, the quality of life in the Troy area with mine development is overall determined to be negative, slightly more so than without mine development.

h. Social Services and Public Facilities

(1) Housing

(a) Troy Census Division

Table II-18 shows combined normal growth plus mine impact housing needs for the Troy Census Division. Housing requirements for normal population growth is based on an average family size of 3.4 persons which was determined by the 1970 census. Housing requirements for mine construction and mine operation employees are based on an average family size of 2.28 and 2.82 persons, respectively.

Table III-18 shows that the mine impact population would require 18 temporary and two permanent dwelling units during the first year of construction.

Table III-18 Troy Census Division Dwelling Units Needed wthout and with ASARCO Mine[1]

Year	Without Mine	Additional Dwelling Units With Mine[2] Temporary	 Permanent	 Total
1978	-	18	2	20
1979	2	18	9	29
1980	16	-	17	33
1981	18	-	13	31
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1990	-	-	-	-
1995	1	-	-	1

[1] Excluding Bull Lake Area.

[2] Temporary dwelling units are those required for mine construction workers whose work will conclude in 1981. Permanent dwelling units are those required for mine operation employees. Surplus temporary housing has not been used to meet permanent housing needs.

The 1978 impact population demand for housing of 18 units to house construction workers can be met by the existing supply of mobile home facilities. There are very few rental units listed in the Troy Census Division at the present time but with the impact demand, some units would undoubtedly come onto the market. In an April issue of the Western News, houses for sale in the Troy area consisted of 4 mobile homes and one single family unit.

The peak construction impact housing demand would occur in 1979 when the total construction demand will be 36 units. It would be desirable to meet this demand by expansion of existing trailer parks or construction of additional mobile home parks so that temporary impact housing needs are not scattered throughout the surrounding undeveloped area. It is unlikely that a large portion of the temporary population would reside within the Troy city limits unless there is construction of apartments or other temporary residential units such as an additional motel with kitchenettes.

The Troy Census Division would require an additional 41 permanent dwelling units by 1981 to house permanent ASARCO mine employees.

The majority of the permanent population could also locate outside the Troy city limits. At present, there are plans for a major subdivision west of Troy of 60 to 70 acres. Tentative plans are for one-acre lots. This would be sufficient to house the entire projected permanent population.

The Town of Troy has a number of vacant lots. However, the advantages of locating with in the town limits to take advantage of the municipal water system is diminished by the fact that water is easily obtained by wells in the adjacent areas. Since Troy has no central sewer system, continuation of development would increase the possibility of groundwater pollution. Because there is a central water system, pollution of drinking water would not be a problem, however, due to a high groundwater table, there is a possibility that surface drainages could become polluted causing a health hazard. Increased densities within the Troy city limits would increase the feasibility and need for a central sewage treatment facility.

(b) Bull Lake Area

Table III-19 shows housing requirements for the Bull Lake area. This area includes the northern part of Sanders County.

Table III-19 Bull Lake Area Dwelling Unit needs without and with ASARCO Mine

Year	Without Mine	With Mine		Total
		Temporary	Permanent	
1978	-	28	2	30
1979	2	28	14	44
1980	4	-	26	30
1981	3	-	20	23
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1990	-	-	-	-
1995	2	-	-	2

The Bull Lake area has four trailer parks that could be expanded to meet some of the temporary housing needs. Fifty-six temporary dwelling units will be required during the construction phase of the project. Sixty-two permanent dwelling units would be needed to house permanent mine workers.

Figure II-23 shows that most of the land desirable for development (slopes 0-15 percent) lies along the major drainages in the Bull Lake area. Figure II-24 shows that the soil types in these areas is classed as "forested soils on glacioflurial terraces". This is the same soil type as the south Libby Flats area. As discussed in a foregoing section, development of South Libby Flats to the present density has resulted in some pollution of wells from septic systems.

(c) Libby Census Division

Thirty-five percent of the new residents coming into the impact area due to the ASARCO mine, have been estimated to locate in the Libby area. The resulting housing needs are shown in Table III-20.

The Libby Census Division could require a total of 339 dwelling units by 1995, to house normal growth and ASARCO mine impact population.

There would be a need for 49 temporary dwelling units to house mine construction employees during the two year construction period.

Table III-20 Libby Census Division Dwelling Unit needs without and with ASARCO Mine

	Without Mine		With Mine	
Year		Temporary	Permanent	Total
1978	-	25	2	27
1979	18	24	12	54
1980	100	-	21	121
1981	97	-	19	116
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1990	-	-	-	-
1995	21	-	-	21

The April 6 edition of the Western News lists six mobile homes for sale in the Libby area and one listing for mobile home spaces for rent in the Libby area. No houses or apartments were listed for rent. Existing mobile home parks probably have sufficient space or could be expanded to meet the temporary housing requirements.

The April 6 Western News had 20 houses listed for sale in the Libby area. Prices ranged from $10,500.00 to $79,500.00. The average price was $42,600.00.

Based on the amount of available housing, there would be a need for construction of 270 permanent dwelling units by 1995. There is sufficient, developable land west and south of Libby for this growth to take place.

The estimated housing needs for the Libby area are well within the land capabilities of the area. Due to existing services and utilities, these additional units could be accommodated with less impact than the other two areas would experience.

The higher quality housing in the Libby area and the city services and social opportunities offered would be an attraction to the permanent impact population associated with the mine. The permanent impact population would consist of new residents who move into the area for the purpose of working at the mine or new residents who come into the area as a result of the mining activities such as persons employed in service industries that expand as a result of the increased population due to the mine operation.

There are a number of available mobile home spaces in the area; however, temporary construction employees may prefer locations closer to the mine site if available. This was apparent during the Libby Dam construction when the majority of the workers were housing in high density mobile home parks along Highway 37 in the vicinity of the dam site. Other workers scattered in mobile homes on single lots, especially in the South Libby Flats area where there were no city taxes but city conveniences were within easy range.

It is not anticipated that there would be an influx of mine construction workers into the Libby area. These mobile families would more likely locate closer to the mine site in the Bull Lake and Troy areas.

(d) Summary of Impact Area Housing Needs

Table III-21 summarizes the estimated dwelling unit needs for the impact area including the LIbby and Troy Census Divisions and the Bull Lake area.

Table III-21 Impact Area Dwelling Unit needs without and with ASARCO Mine

	Without Mine	With Mine		
Year		Temporary	Permanent	Total
1978	-	71	6	77
1979	22	70	35	127
1980	120	-	64	184
1981	118	-	52	170
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1990	-	-	-	-
1995	24	-	-	24

Normal growth would require 284 additional dwelling units in the impact area by 1995. There could be a need for 141 temporary housing units to meet the needs of the ASARCO mine construction workers during the two year construction period. Permanent mine workers would require 157 new dwelling units.

During the peak construction period the demand for temporary housing would probably be greater than estimated due to workers coming into the area seeking jobs but unable to obtain employment. The extent of this demand could depend on the amount of area and regional unemployment during the construction period.

There would be a surplus of temporary housing by 1980, however, it is not anticipated that this housing would be suitable for absorption into the permanent housing supply. Much of this housing could be mobile homes which may be removed. Other dwelling units such as rooming houses and motels with kitchenette would not be desirable for permanent dwellings but may fill a need in the low income market.

(2) Water and Sewage Systems

(a) Troy Water System

The Troy water system has a capacity to serve an estimated population of 2,160. Normal growth estimates show a 1995 populaion of 891 for Troy. The maximum impact population occurs in 1981 and is maintained at 250 persons through 1995. This gives a combined normal growth plus impact population of 1,141 persons which is within the capacity of the system.

(b) Bull Lake Water System

Normal growth plus impact population in the Bull Lake area is estimated to be 865 persons by 1995. Unless growth were controlled, development would be scattered and it would not be feasible to construct centralized water systems. If scattered development were allowed to take place, water would be supplied by individual wells. Water well records show that there is abundant groundwater in the area, capable of satisfying the projected needs. The quality of the groundwater could be affected by scattered development which would make centralized sewage systems infeasible. A typical example of this type of development is South Libby Flats which has now reached a density where pollution pf groundwater may force the construction of a centralized sewer system.

(c) Libby

The estimated 1995 City of Libby population is 3947[1] persons. The impact population is estimated to be 350 for a combined normal growth and mine impact population of 4294 persons. The Libby Census Division would have a 1995, combined normal growth and mine impact population of 12,090. The Libby water system has a capacity of 11,425 persons. Much of the 1995 population would be located in the suburbs of Libby which, due to low densities, would not be feasible to serve with the existing water system. The existing water system is capable of meeting the 1995 normal growth and mine impact needs. Service to new growth areas would require construction of new supply lines and extension of the distribution system.

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[1] Montana Population Projections, 1975-2000. Department of Community Affairs, Division of Research and Information Systems 1977.

(d) Troy Area Sewage System

Increased densities within the Town of Troy would make the construction of a centralized sewer system more feasible. In the absence of a centralized sewer system, the additional impact development will add to pollution of groundwater in the Troy area.

(e) Bull Lake Area Sewage System

Construction workers coming into the area to work on the mine facilities would likely locate as near the mine site as possible. There is a large amount of developable land that is in private ownership in the Bull Lake area. If land use controls are not implemented, scattered development may take place throughout the Bull Lake area. Control of development in the area through county zoning districts, subdivision laws and other development control measures could result in higher density developments that would be feasible to serve with centralized sewage systems.

(f) Libby Area Sewage System

The existing primary treatment plant has a capacity of 6500 persons. This is sufficient to meet the projected normal growth and mine impact population of 4297 persons plus extension of the system into adjacent areas to serve an additional 2200 persons. This would cover those areas that have high enough densities to make service extensions feasible.

(3) Solid Waste

(a) Troy Census Division Including Bull Lake

Based upon the existing level of service, 15 cubic yards of additional container capacity would be necessary to meet normal growth requirements by 1995. This is an increase of 6 percent over the present operation. The ASARCO mine impact population would require an additional 83 cubic yards of container capacity. The total expansion to serve the normal population growth plus the ASARCO mine impact population would amount to an increase of about 40 percent of the existing container capacity. This increase would require an additional packer or more frequent collection trips.

(b) Libby Area

The private operation in the Libby area would need to acquire additional equipment to service normal population growth plus the mine impact population.

(c) Disposal

The mine impact population would reduce the time by which a new disposal site would be required from 35 to 40 years to approximately 20 years.

(4) Schools

Table III-22 shows school enrollment estimates for the Troy and Libby Districts with normal growth plus the ASARCO mine impact population.

Table II-22 Educational Needs Summary Impact Area Enrollment vs Capacity

Troy School District

School Year	Elementary	High School	Total
1977-1978 (actual)	407	218	625
1980-1981	520	279	799
1985-1986	563	302	865
1990-1991	566	304	870
1995-1996	573	307	880
Capacity (1977)*	549	300	849
Surplus/Deficiency	-24	- 7	-31
New Teachers Required	10.0	4.5	14.5

*An addition of six to eight rooms is presently underway.

Libby School District

School Year	Elementary	Junior High	Senior High	Total
1976-1977	1,452	770	714	2,936
1980-1981	1,530	811	752	3,093
1985-1986	1,546	820	760	3,126
1990-1991	1,565	830	770	3,165
1995-1996	1,592	844	783	3,219
Capacity (1972)	2,070	1,200	1,020	4,290
Surplus/Deficiency	+479	+356	+237	1,072
New Teachers Required	10.0	6.0	6.5	22.5

In the Troy School District, the maximum elementary and enrollment would be reached in 1995. Elementary enrollment would exceed the existing capacity by 24 students, however, the current expansion program would add sufficient classroom capacity to meet the projected needs.

The high school would be operating at capacity by 1995. Planning for expansion to begin by that year should be initiated by 1985.

The Libby schools have sufficient capacity to accommodate the projected student population. Excess capacity could be utilized to meet needs outside the district on a reimbursement basis, if needed.

Normal population and ASARCO mine impact population locating in northern Sanders County would be in the Noxon and Heron School Districts.

The 1977-1978 enrollment in the Noxon elementary school which serves grades Kindergarten through Eighth is 120 pupils. This is the capacity of the school and additional enrollment would require expansion of this school.

The Noxon High School has a current enrollment of 100 students. The capacity of the school is approximately 150 students. This is sufficient to serve the normal growth plus mine impact population.

The Heron Elementary School serves grades One through Eighth. This school would be only slightly impacted by the mine population because it serves the area west of the Bull River turnoff. The school has an existing enrollment of 47 pupils compared to a capacity of 60. This would be sufficient to serve normal plus impact population growth.

(5) Recreation

The four Forest Service developed recreation sites in the project area would experience increased use as a result of the proposed mining development. The additional use would result in accelerated wear and increased maintenance and repair costs and some overcrowding at times. Dispersed recreation areas would also receive increased use as a result of the additional people in the area. These areas would be able to accommodate the additional use without a significant reduction of the recreation experience.

If additional growth in the Bull Lake area is clustered, additional recreational areas could be provided by developers in conjunction with subdivision requirements.

(a) Troy

The existing recreation facilities maintained by the Town of Troy are generally in need of repair. These facilities have the capacity to serve the projected impact population.

Surrounding timberlands, especially those that are owned by the federal government, provide recreation opportunities for hiking, hunting, fishing and skiing. The influx of the impact population will place added pressure on areas offering this type of recreation; however, there are a growing number of tourists visiting the area which causes increasing pressure on the more accessible areas.

A Bureau of Outdoor Recreation grant for improvement of the existing athletic field and recreation facilities located near the W. F. Morrison Elementary School, was recently approved.

(b) Libby

The Libby area has a number of neighborhood parks sufficient to serve the recreation needs of the impact population. Plans are underway to construct a new municipal swimming pool. The combined public and private recreation facilities provide a higher level of service than is found in most communities of this size.

(6) Public Safety

(a) Lincoln County Sheriff Department

At present there is no sheriff substation in Troy nor is one planned. Normal growth plus mine impact growth would add 760 new residents in the Troy Census Division (includes Bull Lake) by 1995. This population increase would be an increase of 32 percent over existing population. Three hundred and fifty-five of the new residents would be located in the Bull Lake area. Due to the response time for these areas from the Libby office, it may become desirable to locate a sheriff substation in Troy.

The existing level of service in Lincoln County amounts to approximately one sworn officer per 1100 persons. Based on this ratio, the county wide increase in population due to normal growth plus increase mine impact population would require two additional officers by 1995. The mine impact alone would require one additional officer by 1981.

(b) Troy Police Department

Based upon the present level of service, one additional uniformed officer would be required to meet the demands of the impact population (existing ratio is one officer per 222 persons).

(c) Libby City Police Department

The existing level of service provides one police officer per 370 persons. The ASARCO mine impact population expected to locate in the Libby area would require one additional officer by 1981.

(d) Fire Protection

The following improvements were recommended by the Troy Volunteer Fire Department to adequately serve the mine impact population plus normal population growth in the Troy and Bull Lake areas.

1) The Troy Volunteer Fire Department is in need of better smoke equipment, fire clothes and boots.

2) Troy Volunteer Fire Department is in need of a better communications system.

3) The Troy Volunteer Fire Department is in need of more building area for vehicles and equipment.

4) Troy Volunteer Fire Department is in need of more volunteers for rural fires.

The Libby Volunteer Fire Department has adequate capability to serve the mine impact population with its present personnel and equipment.

(7) Welfare and Health Services

(a) Public Welfare

Additional population due to the mine impact and normal population growth will require three additional eligibility technicians. This would increase the total number of eligibility technicians from four to seven. The supervisor would no longer be able to assist in eligibility determination because of the additional supervisory workload.

(b) Social Services

The increase in population due to the mine impact and normal population growth would require three additional social workers, one additional homemaker and two additional clerical personnel.

An interview with the program director indicates that the social service workload increased out of proportion to population increase during the Libby Dam construction period. Many transients came into the area seeking work who could not qualify for available jobs. Many of these persons relied on public welfare and social programs for support.

(8) Health Services

(a) Health Care Personnel

Normal population plus mine impact population would require one additional physician[1]. Mine impact population located in northern

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[1] Based on general standard of one physician per 1,222 persons.

Sanders County would probably help to use the Libby Hospital rather than the Clark Fork Hospital in Plains due to travel time. The Libby Hospital would have adequate capacity to handle this small increase in service demand.

(b) Hospitals and Ambulances

Although federal hospital standards now under review may require a reduction in the number of beds at St. John's Lutheran Hospital in Libby, the 1973 Montana Hospital Plan calculated a need for 29 beds. Using this ratio as a standard results in a need for 30 beds by 1995. The existing supply of 34 beds is sufficient to meet this need[1].

Analysis of the Troy and Libby ambulance systems show that some improvements would be required to meet normal population growth requirements. These improvements would enable the systems to serve the mine impact population without additional capacity.

(c) Extended Care Facilities

The mine impact population should have a proportionately low requirement for long-term care facilities because age of the new residents would be in the productive age groups ranging from 16 to 62 years of age. Over the life of the mine operation, some workers would reach retirement age and may require extended care facilities. It is not anticipated that expansion of the existing facility would be required to specifically meet the needs of the mine impact population.

(9) Transportation

(a) Streets and County Roads

(i) Troy

The major local streets serving the Troy urban area are Third Street, Kootenai Avenue and Riverside Drive. These are all two-way, two lane streets. Normal growth will add 37 dwelling units to the Troy are by 1995. The mine impact could add another 77 dwelling units. Total traffic generated by new dwelling units would be approximately 1254 one-way trips per day. This traffic would not have a concentrated impact on any single street.

An additional traffic impact associated with the ASARCO mine will be the concentrate truck traffic. Ore trucks would make three round trips per day from the mine site to the railroad loading area which will be located east of the city jail on Yaak Avenue. Although the volume of truck traffic would be low, the weight of the trucks may cause breakup to occur on Yaak Avenue between the ore loading site and U. S. Highway 2. This street may require reconstruction in order to carry the ore truck traffic over the mine life period.

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[1] Montana State Plan, Hospital and Medical Facilities Construction, Montana State Department of Health and Environmental Sciences and Hospital and Medical Facilities Division 1973.

(ii) Libby Area

Normal population growth and mine impact population could generate an additional 3700 trips per day. A typical, two-way two lane street with parking has a capactiy of 7400 to 8200 vehicles per day[1]. Due to heavier volumes of traffic, street maintenance will increase, accidents would generally increase and delays will increase. Since the normal growth and ASARCO mine impact population would be distributed over the Libby urban area, traffic increases would not be concentrated in one location and increased traffic demands can be handled by the existing street system.

(b) Highways

The primary impact on the highway systems would be from increased traffic generated by mining employees and ore trucks hauling ore from the ore concentrator to Troy. The existing condition of Route 202 and the reconstruction of U. S. 2 between Libby and Troy is capable of handling the anticipated increase in traffic associated with the ASARCO project. The Montana Department of Highways measured current use of the highway system and projected future use considering the ASARCO Troy Project traffic as follows:

	1977 Vehicle/Day Traffic Counts	Vehicle/Day Traffic Projections
Route 202	418 - 720	1040 (year - 1996)
U. S. 2	1831 - 3138	4190 (year - 2000)

Some traffic delays and possible safety hazards may occur caused by vehicles making left turns at the intersection on Route 202 and Route U. S. 2 and again at the mine access to Route 202, particularly during employee shift changes at the mine.

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[1] Highway Capacity Manual - 1965.

The majority of traffic noise generated by the ASARCO project will come from construction or mine personnel going to and from the mine area rather than from concentrate haul trucks (estimated at three trucks per day). In order to arrive at an estimated volume of traffic generated by mine personnel, 60 percent of the maximum number of vehicles possible was used. The figure arrived at was 360 cars per day. Also used was an estimated figure for large trucks which includes concentrate haul trucks and other trucks related to the mine construction phase and operational phase. The figure used was approximately 12 percent trucks.

Noise readings were taken on July 20, 1977 at a total of six locations along U. S. 2 and Route 202 (Figure II-27). The following noise measurements were obtained for each location by the Montana Departments of Highways:

Location *(L_{10} dBA)	1977 (measured)	1980 (est. construction period)	1999 (normal growth and ASARCO)	1999 (normal growth only)
No. 2	65	66	73	72
No. 3	69.5	71.5	76	76
No. 4	56	59	63	60
No. 5	56	58	62.5	60
NO. 6	56	59	63	61

*Noise level exceeded 10 percent of the time (maximum limit: Residential = 70 dBA and Commercial = 75 dBA).

Columns 1 and 4 for each location are based on measured L_{10} projected to the year 1999 allowing for normal growth of traffic. Columns 2 and 3 are based on estimated traffic growth as a direct result of the ASARCO mining operation.

Because of the possible number of variables involved, it is difficult to accurately predict what the actual impact of the ASARCO project would be. The Department of Highways projected estimations for the maximum impact. Taking into account the tendancy for projected noise levels to be somewhat higher than actual values, the projected L_{10} figures for each location do not appear to be in excess of allowable limits.

Construction of the mine access road approach to Route 202 would disturb the existing ground surface within the highway right-of-way and cause a potential for additional erosion and sedimentation.

Highway maintenance cost would increase because of population and traffic increase associated with the mine development and operation. These costs would be partially compensated by revenue collected from fuel and gross vehicle taxes that are indirectly returned to the system.

(c) Forest Roads

The primary impact of the proposed mine development on the existing

Forest transportation system in the area would be the use of the exising road up Stanley Creek for access to the mine-mill site. The existing road is presently not designed to accommodate the increased traffic that development would bring. The access route is proposed to be redesigned and reconstructed to adequately accommodate this additional traffic for year-round use.

The design, when completed, will meet design criteria for a road receiving an average daily traffic count of 409 and meet necessary construction constraints for cut and fill prior to acceptance and approval by the Forest Service.

Other Forest system roads in the area would not be directly affected by the proposed mining development. The indirect impact of the increased population growth due to the mine development on road use for recreation, hunting, wood gathering and berry picking could be heavy. Increased use could pose a safety problem for the users as well as increase wear on the road surface and cause dust problems.

(d) Other Travel Modes

Other travel modes including bus, taxi, railroad, air travel have sufficient capacity to accommodate increased travel demands due to normal growth and the mine impact.

Transportation of the ore concentrate from the loading site east of the Troy City jail to market, could require an additional 12 to 15 rail cars per week.

(10) Aesthetics

The majority of the proposed mining development is within a moderate Viewing Significance Zone as seen from Highway 202. The impact upon the area viewed from Highway 202, Bull Lake, county roads and the Cabinet Wilderness area would be slight, with the exception of the proposed tailing impoundment. Because of the proximity of the tailing impoundment to Highway 202, the potential for a high visual impact would exist. The impoundment area is sheltered from Highway 202 by a natural topographic feature and a screen of trees. However, after several years of operation, the impoundment area would become a prominant landscape feature and highly visible because of it's size and height.

As viewed from the mine access road the tailing pipeline and transmission line would present a highly visible aesthetic impact. The mine and mill site would not be highly visible from the mine access road until the viewer was very near the proposed facilities.

Visual impacts associated with the proposed transmission line and suggested mitigation as prepared by the Department of Natural Resources and Conservation, Energy Planning Division are contained in Appendix V. The impacts identified for that section of transmission line proposed to parallel the mine access road can be regarded as equally applicable to the proposed tailing pipeline.

(11) Archeological and Historic Sites

There would be no direct impact to any known archeological or historical sites by the proposed mining development. Population growth as a result of the mine development, and increased use of the general area for development and recreation would directly impact possible archeological and historic sites in the Lake Creek and Kootenai River valleys.

Although surveys to date do not show any archeological or historical sites within the project area, care would have to be taken to preserve and evaluate any hidden sites uncovered during the development of the project. The potential for an unidentified site occurring in the area proposed for the tailing impoundment development is medium.

D. Significant Adverse Impacts that cannot be Avoided if the Proposals are Implemented

1. The Physical Environment

a. Topography

Although the proposed project would result in an unavoidable alteration of the existing topography in several areas, the alteration is not considered to be significantly adverse.

b. Air Quality

The proposed development would result in increased activity in the area and would unavoidably result in some deterioration of air quality. The deterioration, however, would be primarily limited to short-term increased levels of total suspended particulate during the development of project facilities and is not considered significantly adverse. The surrounding area would experience a longer term increase in total suspended particulate levels associated with increased population and traffic.

c. Mineral Resources

Successful completion of the proposed mining and milling activity would result in a reduction in the known domestic copper and silver reserves. ASARCO reports that the anticipated amount of ore to be mined is 48,000,000 tons (ASARCO, 1976). The average metal values reported are 0.74 percent copper and 1.54 ounces of silver per ton. These figures yield the following anticipated cumulative production of metal over the lifespan of the mine: approximately 74 million troy ounces of silver and 355,280 tons of copper. This amount of copper and silver metal will be removed from the nation's known reserves (McKelvey, 1972) of identified ore deposits, economically developable with existing technology.

Estimates of domestic supplies of copper from 1973 figures (Pratt and Brobst, 1974) by the U. S. Geological Survey show 180 million tons of copper metal reserves yet to be developed. It is also estimated that U. S. reserves of silver metal to be 1,300 million ounces. These reserves are considered by the USGS (1976) to be inadequate to fulfill the nations needs beyond 25 years. Occurrences of copper and silver that are now hypothetical resources eventually may be considered to be reserves, as technology, projected need and economic situations change.

The depletion of previously adjacent minerals and construction materials would not be significant during the life of the project. The rock material or quartzites which would be separated from the metal bearing material would only be converted or changed in physical size. The amount of quartzitic material available in western Montana is enormous and any depletion of this resource base cannot be calculated; however, some of this quartzitic material would be effectively and efficiently utilized in the construction of roads, pad for the mill facilities and the dam for the tailing impoundment. Without this project, this quartzitic material would most probably not be utilized.

d. Soils

The productive capacity of approximately 400 acres of native soil to produce vegetation and important wildlife habitat would be lost for the life of the proposed project.

e. Water Resources

The normal operation of the proposed facilities would not result in a significant impact to the area's water resources. Infiltration of water through the proposed tailings pond and subsequent movement to Lake Creek may cause a change in local surface and groundwater quality, however, it is anticipated that this change would be small or insignificant due to the relatively small amount of seepage and the large amount of dilution in Lake Creek. The net change in quality of Lake Creek probably would be difficult to detect by standard sampling and analytical testing procedures. Movement of tailing into Lake Creek or Stanley Creek as a result of facility failure would cause a significant adverse impact to water quality.

2. The Biological Environment

a. Flora

Construction and operation of the proposed tailing impoundment would require the removal for the life of the project of more than 400 acres of native vegetation considered important as wildlife habitat.

b. Aquatic Productivity

Normal operation of the proposed facilities would not have a significant adverse impact upon the aquatic productivity of the area's surface waters.

c. Terrestrial Fauna

Because of the constraints, lack of previous data and the diversity of wildlife in the area, additional information would be necessary in order to accurately assess the potential for significant adverse impacts to the wildlife as a result of the proposed project. However, for reasons including habitat alteration and destruction, increased human access and activities, direct mortalities and disruption of seasonal travel routes, it is believed that the proposed project has the potential for significant adverse affect upon local populations of mountain lion, mountain goat, moose, black bear, both species of deer, elk and the mountain bluebird. In particular, additional information regarding the fawning, and calving characteristics of the local populations of ungulates would be useful in better determining the magnitude of the adverse impacts associated with the project.

3. The Social and Economic Environment

a. Land Development

The mine impact is anticipated to result in a conversion of 112 acres to urban uses, assuming that none of the inmigrating mine impact population locates in available vacant housing. The major impact would be in the Bull Lake area where an additional 45 acres would be required to house and service the mine impact population. The impact would be greater here because of the rural nature of the area.

b. Quality of Life

The increased population and development associated with the proposed mining project would result in a significant decrease in the quality of life for those individuals who consider the existing condition as desirable to maintain. Following completion of the mining project, if the area has not developed a stable and diverse economy, the "bust cycle" would also result in a significant decrease in the quality of life as established during the life of the mine.

c. Social Services and Public Facilities

The initial impact of construction workers would tend to raise housing costs for the lower income residents of the area. There would be a demand for mobile homes, apartments and rooms which are typically low income housing. Although there are a number of vacant mobile home spaces in the area, the demand for these facilities may result in significant rental price increases. In the same manner, completion of the construction phase of the project would result in a surplus of this type of housing which may result in a decrease in housing costs for the lower income population sector.

Increased population densities in the Troy area would increase the need for a central sewage system. This impact may not be adverse in that the increased density would increase the assessment base for funding a sewer system. However, the economic impact on fixed income and low income residents would be significant.

Increased enrollment in the Noxon Elementary School as a result of mine related development would require expansion of the existing facility.

d. Visual Resource

As viewed from the mine access road the tailing pipeline and transmission line would present a significant adverse visual impact, as would the proposed tailing impoundment during the life of the project.

E. Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

The following discussion appraises the extent of long-term impairment or enhancement of resource values that would occur, given the proposed short-term mining of copper and silver in the Troy area. In this analysis of trade-offs over time and trade-offs among resource values, short-term refers to that period of approximately 20 years during and immediately following the proposed operations when mining and reclamation are to take place. Long-term is that period thereafter during which consequent impacts, both adverse and beneficial, still affect the environment.

In consideration of the relationship between the proposed short-term use of the environment and the maintenance and enhancement of the area's long-term productivity, the possibility for failure of the proposed facilities must certainly not be ignored. The possibility of such a failure, however, as discussed earlier, is difficult, if not impossible to predict. Therefore, the reader is referenced to the earlier impact discussions, for an indication of the magnitude of the potential for the effects of a facility failure upon the productivity of each of the area's resources. The following discussion considers only the normal operation of the proposed facility.

1. The Physical Environment

a. Topography

The proposed activities would result in a permanent change in topography at the mine site, mill site and tailing impoundment, thereby introducing long-term changes in related environmental factors affecting long-term productivity of the area. Changes in slope magnitude and slope aspect or direction would alter the local microclimate, producing corresponding changes in type, density and vigor of the plant cover. This in turn would affect infiltration, runoff, erosion and sedimentation and productivity or carrying capacity for wildlife.

b. Air Quality

ASARCO's proposed development, a short-term use, would increase the total suspended particulate levels in the air during the development and operation of the project. The cessation of this activity would end the impact on air quality directly related to the project. It is expected that the influences on the air quality from the population growth associated with the development would continue.

c. Mineral Resources

The proposed mining and milling activity represents a short-term productive use of the mineral reserves; although, reclamation and recovery time for the environment may be substantial and the environment would not return completely to its original condition. If the quartzite rock that contains the ore body is determined to be an adequate rock source material, use of the land for extracting rock materials could continue after the metallic ore body is depleted.

The long-term effect on the productivity of the locatable mineral resource present will be a decrease in productivity until the mineral resource of the mine is totally depleted. Limitations in current technology of the room and pillar method to be employed will necessitate as much as 25 percent of the ore body in place as roof support in order to extract 75 percent of the mineral resource. At the present time, the remaining ±25 percent of the ore body could not be removed economically. The long-term effect of the mining activity will leave 25 percent of the ore body, this amount must be considered to be necessarily unproductive because of current limitations in mining technology.

It is possible that if this deposit were extracted at some later date, rather than at present, a greater percentage of the ore body could be extracted; however, under the U. S. and State of Montana Mining Laws, the mining claimant has the right to decide when the locatable mineral resource will be extracted, subject to pertinent regulations.

The portion of the mineral resource remaining when the proposed mining activity ceases may be considered to be economically significant at some point in the future, thus prolonging productivity. Extraction of the remaining mineral resource may be planned at that time; such a decision would require tremendous advances in technology

d. Soils

Soil disturbances on approximately 1,200 acres as a result of the proposed action would alter soil characteristics and probably cause some long-term decline in soil productivity. Soil losses would occur from accelerated erosion on denuded and disturbed areas during operation and reclamation. Also, organic content and biological activity in the replaced surface layer would be decreased by mixing soil and by stockpiling. Although there may be some minor changes in the soil productivity, permeability, infiltration and depth, the basic soil characteristics would be present to sustain the long-term productivity of the soils.

e. Water Resources

Upon completion of the mining program, the hydrologic system should return to its pre-mining condition with little or no change in long-term productivity.

Groundwater used to supply makeup water for the mineral processing facility would, upon completion of the mining project, cease to be withdrawn for this use. Within the mine, waters encountered during mining would continue to flow from the mine workings and eventually into the stream system. Based on present water quality, it is anticipated that this would have a minor influence on the stream systems.

After reclamation, waters that would percolate through the soils and revegetated area of the tailings pond, should decline in quality. By downward percolation, this water would enter Lake Creek. It is anticipated, however, that only small quantities of water would percolate entirely through the reclaimed tailings pond. Also, dilution in Lake Creek should prevent any measurable long-term impact to the stream.

2. The Biological Environment

a. Flora

At no time, would the entire area proposed for disturbance be devoid of vegetation, inasmuch as reclamation activities, particularly those which relate to control of erosion, would, to the extent feasible, be conducted simultaneously with mining and in any case would be initiated promptly after completion or abandonment of mining on those portions of the mine complex that would not be subject to further disturbance by the mining operation (Section 9 (50-1209) (a) of the Montana Hard Rock Law). Given successful reclamation, the productivity of the disturbed acreages should be interrupted only for the time required for mining operations to be completed and for permanent revegetation to occur. If reclamation is not successful on all or any part of the disturbed areas, then the long-term productivity of the vegetation resource will have been partially sacrificed for the short-term benefits that the mineral resource provides.

Vegetation on areas that have been utilized for roads or facilities may not return to a permanent, diverse cover within the near future (short-term) as a prolonged time period is required for succession to occur. Diversity, however, is not necessarily a requirement for a productive vegetation resource.

Species or communities requiring topo-edqphic conditions that are not duplicated by reclamation practices would be eliminated from reclaimed areas for a period considerably longer than the short-term.

Increased human population growth in the general area is another short-term use of man's environment that may have long-term affects on vegetation productivity. Increased foot and vehicle travel on adjacent lands, if abusive, would result in long-term destruction to the soils resource in localized areas outside the project boundaries, thus impairing vegetative productivity.

Dust from mine-related and secondary activities could also affect the short-term productivity of vegetation outside the project boundaries. Given successful reclamation of disturbed areas, dust impacts on vegetative productivity should not be long-term.

b. Aquatic Productivity

The anticipated activities of ASARCO are not expected to have a significant effect on the long-term productivity of surface waters in the Lake Creek drainage. Secondary development may result in increased use of the area's surface waters for recreation (primarily fishing) and could cause a short-term reduction in the native fisheries population.

c. Terrestrial Fauna

For many wildlife species in the Lake Creek valley there would be no short-term gains, only long-term losses if the ASARCO proposal is implemented. Forest-dwelling species would not realize any benefits, and many open country species, which positively respond to habitat alteration (such as over-story removal) would realize few, if any, benefits from the development of the mine and it's facilities.

It is both an economic and an aesthetic question whether short-term gains to economic growth would equalize long-term losses to outdoor enthusiasts, photographers, hunters and recreationists in general. The impact of more than 300 potential mine workers and their families would result in increased demands upon the Lake Creek valley to supply recreational opportunities. In the case of hunting, increased pressure has resulted in increasingly restrictive hunting seasons and the long-term loss of recreation to sportsmen.

Comparing man's short-term economic gains through extraction of resources to the environment's long-term process of attaining dynamic stability, there is a point at which alteration of the environment results in irretrievable losses of wildlife resources. In the case of ungulates, those species which are able to more efficiently utilize the resource will, through competitive exclusion, replace less adaptable species. Habitat utilization and behavioral mechanisms for each ungulate species would have to be determined before predictions could be made regarding the tenacity of each. Short-term competitive exclusion does not ensure long-term survival given increasing development.

3. Social and Economic Environment

a. Social Environment

The assessment of the effect on social values with the advent of the ASARCO mine has already been addressed previously. An attempt to compare the losses in social values against any gains that the mine would bring can only be judgmental. Such judgment will vary from individual to individual largely dependent upon each person's situation.

The most obvious social change would be population growth. Growth would bring new people, greater activity, generally more "urbanization", increased demand for public services and recreation facilities, greater housing needs, etc. To many existing residents who have selected a lifestyle of relative seclusion and slower pace, these changes would be detriment and a real loss in their quality of life. Others may view some or all the changes as beneficial. In particular, some individuals may enjoy greater activity and the potential for more "cultural" events.

Certain areas in Lincoln County would probably experience more pronounced social change than others. For instance, the Bull Lake area is presently virtually unsettled, recreation property. It has been projected that 400 people would choose to reside in this area. This would necessitate new homesites, both permanent and temporary (mobile homes), some road development and generally a partial destruction or infringement upon the existing aesthetics. Other areas, such as Troy and Libby, would notice less social change from new population because they are already organized communities with the means to accommodate some growth.

This new growth may bring stability and added support for the social environment which many residents believe has been gradually deteriorating because of the lack of employment opportunities, public revenue resources and stimulus for economic prosperity. The productivity of the mining operation may help to resolve these deficits and as a result, improve or maintain the social values of the area as they now exist.

b. Economic Environment

Lincoln County's economic environment would undoubtedly receive direct stimulation through new employment and mining production. The mining activity may also attract new commerce and bolster what now exists in Lincoln County. Thus, the long-term consequences beyond the mining lifetime may be favorable. On the other hand, without additional industry, a conclusion of the mining operation may lead to high unemployment and a snowballing economic decline. These opposite consequences are the gamble of any large, short-term industrial buildup. However, the projected length of mining productivity provides an opportunity to prevent the latter consequence through careful planning and economic promotion.

c. Archeological and Historical Sites

Archeological and historical sites or artifacts are nonrenewable and hence long-term resources. In the event that significant sites are not discovered and are destroyed during the mining process, the physical resource loss would be irretrievable. In addition to such a possible loss of physical resources, educational and scientific information regarding prehistoric environments and our cultural heritage would also be lost to both present and future generations.

F. Irreversible and Irretrievable Commitment of Resources

1. Mineral Resources

The proposed mining and milling activity would irreversibly commit the copper and silver mineral ore body to depletion. Mineral deposits are unique, highly finite and valuable features of the earth's crust, formed by slow processes still active today. Mining of the mineral resources is a depletion of a resource that will require millions of years to be replenished, possibly never (localized) in the same area.

This depletion must be considered in two phases: 1) the raw mineral resource in the ground and 2) the finished product mineral resource in use. The proposed action would severely reduce the mineral resources of the ore body as it exists in the ground; however, that raw mineral resource which is extracted mineral commodities is becoming increasingly necessary as mineral resources in the ground are limited. It is not currently possible to completely recycle mineral resources; it may never be. However, before the mineral resource in the ground is irretrievably and totally depleted, it may be possible to slow the overall depletion of mineral resources to a point where they only need be replaced when they are destructively used.

The rate at which the depletion of the mineral resource would occur must also be considered in terms of economics and the market values of the mineral commodities involved. Areas surrounding what is currently considered to be an economically exploitable ore body, although not economically significant now, may be exploitable in the future; therefore, depletion of the regions mineral resource may continue after the presently proposed mining activity is completed. Portions of the defined ore body, which would remain when the proposed mining would be completed, because total extraction is not currently economically or technologically feasible, may become significant in the future.

When a commitment is made to remove the metallic mineral resources of the mine, the mine or mill areas may be irretrievably committed to other extractive uses as well. Uses for other mineral materials (quartzite rock, tailings, etc.) may be identified and their extraction and use elsewhere made economically desirable. This latter commitment cannot be predicted at present.

The land itself may be committed to other uses as a result of its initial commitment to the proposed action. Other uses for the mine may be identified and this would delay or halt restoration of the adjacent area.

2. Energy Resources

The proposed mining of copper and silver and the reclamation of disturbed areas at the proposed mine site would require the use of electrical power, liquid fuels in the form of diesel fuel and gasoline, ammonium-nitrate-base explosives, and structural and repair materials. ASARCO estimates it's annual power consumption to be 106,372,000 Kilowatts of electrical energy during the life of the proposed operation; this power would be irretrievably consumed. In addition to power, fuel and explosives, an unquantifiable amount of chemicals and materials used in the mining and subsequent reclamation processes would also be irretrievably lost for other uses.

3. Water Resources

Based on hudrologic data gathered to date, it appears that the proposed project would result in a minor irreversible or irretrievable commitment of water resources.

Drainage from the underground mine would cause groundwater to be removed from storage and added to stream flow. This groundwater, under natural conditions, may have had a substantially longer delay in it's flow to the Stanley Creek stream system. There would be minor consumptive losses of water in the mining and milling facilities during the project.

It is estimated that the mill tailings would hold (bind for a long time) a large quantity of water. This amount would be quivalent to about 292 gpm for the period of the project. This water would be tied up and essentially kept in storage in the tailings pond.

4. Aquatic Productivity

Aquatic biological resources, as renewable resources, would not be irretrievably committed provided the aquatic habitat is left intact. With the exception of a serious spill of tailings, the proposed operation would not alter the existing aquatic habitat.

5. Terrestrial Fauna

The irreversible and irretrievable commitments of the wildlife resource of the Lake Creek valley is difficult to address for a single proposed development. Impacts from the proposed ASARCO development, as well as the impacts from all other present and future developments throughout the valley would probably have a synergistic effect upon each other. The total impacts from all developments would be greater than the sum of the impacts from individual developments.

Unless the mine area and all associated facility sites are reclaimed to their condition prior to disturbances, and unless the human population and associated developments are reduced to the level at which they occurred during the pre-mine era, the reduced carrying capacity and the lowered wildlife population levels must be considered a partial irretrievable commitment of the wildlife resource.

6. Human and Economic Resources

The capital investment in plant and productive equipment at the mining termination is irretrievable and irreversible once committed, if no alternate usage can be found. Labor invested in construction and in mining ore is irretrievable once expended, but the labor commitment is reversible should a premature termination occur. Similar commitments and investments on a smaller scale may develop in the government, trade and service sectors of the local economy with congruent irreversible and irretrievable outcomes.

Such an investment and commitment of human and economic resources is required for any economic activity. But unless the venture fails, this is a beneficial and necessary application of resources to create new employment and new sources of personal income.

The removal of 610 acres of timber production for the lifetime of the mine is an irretrievable postponement of tree growth and creates a substantial delay in timber harvest. However, the process is reversible assuming complete environmental restoration. The timber production and postponement along with the irretrievable destruction of some new growth areas has been assessed a value of $530,000. This loss is insignificant when compared to benefits of utilizing the mineral resource.

7. Archeological and Historical Sites

Archeological and historical resources are nonrenewable. In the event that significant sites are discovered and enforcement of regulation is inadequate, archeological and historical resources could be irretrievably lost. In addition to the loss of physical resources, educational and scientific information regarding prehistoric environments and our natural and cultural heritage could also be lost.

IV. MITIGATING OR COMPENSATING MEASURES

Three basic types of mitigating measures have been recognized as relative to the ASARCO Inc. Troy Project propsal. They are: (1) measures required by Local, State, or Federal laws, regulations, or executive orders; (2) measures proposed by ASARCO as part of their mining and reclamation plan; and (3) other measures generally thought to have merit by the EIS task force. The first two categories include those measures that are binding upon ASARCO and must be implemented upon approval of the proposal and issuance of the various agency permits associated with the mining proposal. By attachment of stipulations, other measures comprising the third category may be required as part of the companies' reclamation plans in those instances where the permitting State or Federal agencies have the authority to do so. Inclusion of these other possible measures in the environmental impact statement affords a practical means of utilizing the expertise of agency members to identify additional measures that, if implemented, would further reduce adverse impacts of the proposal. Inclusion of these other mitigating measures in this statement in no way obligates ASARCO or restricts the decision-making prerogatives of the Federal and State regulatory agencies.

A. Laws and Regulations

1. General Statement

The proposed mining operation must comply with all applicable regulations of Federal, State, and County agencies including:

U.S. Forest Service
U.S. Bureau of Mines
U.S. Environmental Protection Agency
Montana Department of State Lands
Montana Department of Health and Environmental Sciences
Montana Highway Commission
Montana Department of Natural Resources and Conservation
Lincoln County, Montana

Regulations enforced by the above agencies are variously designed to assure realization of the full and best interests of the public, to adequately protect the environment, and to achieve continuing highest productive use of the land consistent with surrounding land uses and management objectives.

2. Federal Laws and Regulations

The 1872 mining law grants the miner the right to mine on Government Land, although this law is still in affect laws have been passed by Congress that effect but do not diminish the miners right to mine on Government Land (Chapter 1, Pages 8-9). These laws and the regulations under which the U.S. Forest Service administers the mining law provide for mitigation of the impacts of mineral development.

The miner must submit for approval an operating plan for his operation prior to doing any work (36 CFR 252.4)). Work will not start without the agency having advance knowledge. Approval of the operating plan is contingent upon it meeting the requirements for environmental protection for air quality, water quality, solid waste disposal, fisheries and wildlife, scenic values, road standards and reclamation (36 CFR 252.8). Prior to approval of a large, complex or controversial operation the agency can require an environmental statement to assure the concerns of other federal, state and local agencies and the public have been heard and answered (36 CFR 252.5). Basically, this gives the agency the tool to assure that the proposed operation is well planned, environmentally sound and that the concerns of all are heard before any major work begins.

The regulations also cover inspection of the work and facilities for compliance with the approved plan during development and operation (36 CFR 252.7 and 252.9). Regulations (36 CFR 252.10 and 252.13) provide for reclamation, removal of structures and clean up when operations cease and bonding to insure that this is done.

3. State Laws

Significant State laws for mitigating impacts include:

(a) Montana's Hard Rock Law defines reclamation requirements necessary for Departmental acceptance of the applicants reclamation plan, as well as other mitigating measures including accomplishment of specific activities, inspections of mining sites to determine compliance with the reclamation plan, performance bonds, and an annual report of activities by the permittee. The Hard Rock Law is contained in Appendix V.

(b) Montana's Clean Air Act (Chapter 39 or Title 69, R.C.M. 1947) and administrative rules adopted thereunder (subchapter 1 of Chapter 14, Title 16, Montana Administrative Code) defines air pollution and provides that the Board of Health and Environmental Sciences may prohibit

> "...the construction, installation, alteration, or use of any machine, equipment, device or facility which it finds may directly or indirectly cause or contribute to air pollution or which is intended primarily to prevent or control the emission of air pollutants, unless a permit therefore has been obtined from it."

(c) Montana's Water Pollution Control Act (Chapter 48, Title 69, R.C.M. 1947) and administrative rules adopted thereunder (subchapter 10 of Chapter 14, Title 16, Montana Administrative Code) charges the Department of Health and Environmental Sciences with the responsibility of regulating water quality by administering a permit system.*

(d) The State Antiquities Act, (Chapter 25 of Title 81, R.C.M. 1947) which is administered by the Board of Land Commissioners and the Montana Historical Society, provides for the registration and protection of historic, prehistoric, archaeologic, paleontoligic, scientific, or cultural sites and objects on State lands. It also provides that the Department is authorized to enter into cooperative agreements with private landowners to preserve, mark, maintain, excavate, or otherwise deal with such sites and objects upon such terms as may be agreed upon.

(e) The Montana Resource Indemnity Trust Act (Chapter 70 of Title 84, R.C.M. 1947, and rules adopted thereunder (subchapter 14 of Chapter 14, Title 42, Montana Administrative Code) provides for a tax on mineral production. The taxes are paid into the resource indemnity trust account. The trust account will be allowed to accumulate until it reaches the amount of one hundred million dollars, at which time the legislature is empowered to appropriate net earnings and all receipts for improvement of this environment and rectifying damages hereto.

(f) Section 32-2412 of the Montana Codes R.C.M. 1947 requires the seeding of borrow pit slopes and shoulders along Federal-aid or State highways using an adaptable perennial grass or combination of perennial grasses and legumes whenever establishment of a perennial grass cover on such sites appears advisible. Section 32-2813 of the Montana Codes R.C.M. 1947 requires the same treatment for county-road construction projects.

(g) The Montana Department of Natural Resources and Conservation (DNRC) is charged with administration of the Montana Water Use Act. The Act is the statutory foundation of Montana's water law and became effective July 1, 1973. Objectives of the Act are three: 1) to institute a permit system for the appropriation of surface and groundwater in Montana; 2) to provide a procedure for the legal determination of all existing water rights, and 3) to establish a system of centralized records of all water rights in the state.

(h) Prior to the construction and operation of certain utility facilities within the State of Montana, an application must be made to DNRC for a Certificate of Environmental Compatability and Public Need. Applications made before April 21, 1975 were filed in conformance with the Montana Utility Siting Act of 1973. Effective April 21, 1975 the Act was revised and renamed the Montana Major Facilities Siting Act.

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* See Appendix H for tentative MPDES permit.

4. Lincoln County Laws

a. Property and Gross Proceeds Taxes

The facilities including equipment and land of the ASARCO project would be subject to a property tax levied by Lincoln County. The proceeds primarily would help fund the Troy school district and Lincoln County. The gross proceeds tax is in effect a property tax on a mineral resource. It would be based on the dollar value of the ore extracted from the mine in any given year.

5. Local Ordinances

There are no significant local ordinances that would function to mitigate impacts from the proposed ASARCO Troy-Project mine.

B. Reclamation Plans and Additional Mitigating Measures

The reclamation plan proposed by ASARCO for the Troy Project is presented in Chapter One, pages 64 through 70. In addition, the following section contains those mitigating, compensating, or monitoring measures generally thought to have merit by the EIS team. Final design plans for the proposed development will be submitted to the Kootenai National Forest and the Montana Department of State Lands for review and approval. Approval will be contingent upon meeting all environmental and administrative constraints required by law. Pending agency review of the final engineering and facility designs, site-specific mitigation recommendations beyond a general consideration are not possible.

Among those measures considered as mitigation are those that involve the implementation of a different or varient plan of operations. Technologic alternatives and their possible application to the proposed ASARCO Troy Project are contained in Chapter Five.

1. Topography

General mitigation of impacts to existing topography would include:

(a) minimization of all cut and fill slopes through proper siting of all facilities to take advantage of existing topography,

(b) hydoseeding all cut and fill slopes in excess of 10 feet with seed mixture containing at least two legume species in the first appropriate season following completion of the cutting and filling,

(c) terracing of all mine waste dumps to enhance future reclamation efforts, and

(d) replacement of a portion of the mine waste dump material within the mined-out portion of the mine.

2. Air Quality

Proposals for mitigating the impacts of the development on air quality involve the control of dust emissions from the mine and mill itself and reclamation of disturbed areas for the road, power line, tailings pond, etc. The use of dust collectors at the mill site would be expected to minimize the emission from the site, and revegetation of the disturbed areas would prevent in large part any of these areas from creating significant particulate problems.

In addition to these measures, paving of the mine haul road could reduce the particulate emissions from the road by 85 percent below that of a gravel road. Reduction of vehicle speed on the road would have a significant effect on the amount of emissions from the road. Reduction to 15 mph from 30 mph, would reduce dust emissions approximately 75 percent. The use of dust suppression chemicals or soil stabilization in the road bed would reduce emissions 50 percent. These control measures deal, however, only with the project facilities and not with the resultant area population and traffic growth. Similar mitigating measures could be employed throughout the growth are to minimize the effect on air quality of the development and growth.

3. Geology

ASARCO will be required to complete rock mechanic studies sufficient to determine that the proposed room-and-pillar operation is within adequate safety limits and that the potential for ground subsidance is not present (Appendix T). Final engineering and facility designs should avoid to the greatest extent practicle, active or recently active faults. Facility design should provide adequate preventive measures should their location involve an active or recently active fault.

4. Soils

a. Road Construction

The mine access road will meet the minimum Geometric Design Standards contained in the forest service handbook 7709.11 for an average daily traffic load of 409 vehicles.

In addition:

1) slope stability studies would be required on cut slopes greater than 10 feet,

2) road cuts in parent rock would be left as near vertical as possible,

3) abandon roads will be ripped to a depth of 16 inches and seeded. Abandon roads in stream washed soils would be covered with soil and seeded, and

4) wet areas encountered in construction will be provided with adequate drainage and stabilized with a rock blanket and/or seeding.

The potential for erosion and sedimentation could be further reduced by:

1) using existing access roads where possible,

2) designing new roads and upgrading existing roads to adequately accomodate the largest and heaviest piece of machinery involved in construction,

3) reducing road grades wherever possible,

4) installing cross-drainages in roads with erodible soils and steep grades,

5) providing a natural vegetation buffer between roads and streams,

6) restricting wet-weather road construction, particularly on poorly-drained erodible soils,

7) prohibiting disposal of excess fill material within the high-water zone of streams,

8) routing surface road drainage onto the forest floor, preferably on benches so that sediment can filter out,

9) minimize the number of stream crossings, and

10) avoiding roads in marshes, bogs, and other areas of extreme wetness.

Where road placement necessitates the direct disturbance of streams, erosion and sedimentation can be greatly reduced by:

1) approaching and crossing at right angles to the stream to minimize streambank damage,

2) installing culverts or arch bridges at major stream crossings or those with importance to the fisheries of the drainage,

3) using culverts with sufficient capacity to carry the largest streamflow expected,

4) avoiding direct use of stream bottom or bank material as a source of construction material,

5) avoiding work within or adjacent to streams during periods of high streamflow, intense rainfall, or migratory fish spawning, and

6) removing excess floatable debris from areas immediately above crossing to prevent culvert or bridge obstruction during higher waters.

b. Utility Corridor

The utility corridor is considered to include the proposed transmission line, tailing pipeline, and reclaimed water pipeline. Construction, maintenance, and reclamation of the tailing pipeline, and reclaimed water pipeline would be required to meet the administrative requirements identified in Chapter One, pages 8 and 9. The proposed transmission line would be required to comply with the Montana Major Facilities Siting Act and the Forest Service's Special Use Permit procedure for site-specific disturbances.

Maintenance of the soils resource is directly linked with maintenance of the vegetation resource. The following mitigating measures were developed by the Department of Natural Resources (DNRC, 1976) for consideration in transmission line construction, however, they can be equally applied to the entire ASARCO utility corridor in consideration of the relationship between native soils and vegetation.

> *Long-term loss of commercial wood productivity from power transmission lines is not highly mitigative. Thus, avoidance of highly productive sites is a prime mitigating measure.*
>
> *Although largely lost to commercial production for the life of the transmission line, the right-of-way need not be abandoned to site deterioration. Mitigating measures that preserve site quality and meliorate visual impact are listed below; they are tempered by practical consideration of line maintenance, economic advantages of mechanical treatment, and the need for slash disposal to reduce the hazards of fire and tree-damaging insect epidemics.*
>
> *Conifers comprise the only family that can threaten line safety in all but riparian areas, and line clearing should be restricted to conifers except where scarification is necessary for construction and fire lines. Conifers (excluding regeneration) within the right-of-way proper should be removed, and the commercial portions utilized. Removal of conifer regeneration would involve scarification and invite a new generation of conifers, gaining little and contributing to site deterioration. Some shrub and herb species, if little disturbed, will prosper in the absence of an overstory and tend to inhibit conifer reproduction while maintaining site integrity.*
>
> *In making suggestions for minimizing initial right-of-way clearing, one assumes that subsequent maintenance will be frequent, that roads will be kept open, and the slash disposal will be no problem. Loss of site quality would be minimized by a thorough initial treatment, followed by revegetation of scarified areas and no further treatment of the area until line safety is again compromised.*

Such a treatment may include removal and use of trees beyond the right-of-way that threatened the line, or may in the future threaten the line. Trees selected for cutting could be chosen according to present height, distance from centerline, and projected growth.

If economically attractive, slash could be chipped for pulp and particle board use. The public could be encouraged to collect firewood from logged areas, further reducing slash.

If enough slash remains to require burning, concentration of slash (e.g., dozen piling) is preferable to broadcast disposal because it minimized exposure of mineral earth and damage to understory species. Burning areas can be chosen to minimize visual impact.

Open roads invite irresponsible vehicular use, resulting in damage to vegetation and site deterioration. Roads closed to public use, with the provision that they may be used for transmission line maintenance, would cause less damage.

Using existing road systems to the fullest extent possible would minimize impacts. Logged areas are preferable to unlogged areas for line location.

Construction practices aimed at prolonging the period before vegetation disturbance is again required, will minimize loss to productive capacity, and is also economically advantageous. Subsequent treatment of vegetation should center on conifer removal, and avoid scarification and damage to herbs and shrubs. Promoting the harvesting of Christmas trees in the right-of-way may reduce the need for future clearing.

Hydroseeding scarified areas can be expected to slow site quality deterioration, inhibit conifer establishment, and increase forage value in forests. A mixture of seed and fertilizer can be hand-seeded (e.g., with a Cyclone seeder) on scarified areas where hydroseeding or drilling is not feasible.

Sediment and sedimentation caused by removal of vegetation associated with the right-ofway clearance can be reduced by:

(1) Positioning right-of-way to avoid the necessity of excessive clearing on steep slopes with erodible soils.

(2) Avoiding any excessive clearing in areas adjacent to stream channels.

If clearing involves removal of marketable logs, sediment can be minimized by:

(1) Avoiding use of stream channels for skidding of logs

(2) Avoiding the falling of trees into or across streams

(3) Locating log landings away from stream channels

(4) Yarding logs uphill and away from any stream

In addition, the Department of Natural Resources and Conservation has reviewed the proposed Northern Lights Inc., ASARCO Project transmission line, and has identified potential impacts and developed suggested mitigation related to the area's aesthetics and slope stability. These reports are contained in Appendix V and W.

c. Mine and Mill Site Facilities

The ASARCO reclamation plan does not propose to salvage topsoil at the mine or mill facilities site, but rather to transport topsoil from the tailing impoundment area for use in reclamation at these sites. It is suggested that if topsoil of adequate depth is encountered during construction of these facilities, that it be used to the greatest extent possible in reclamation of the site immediately following completion of construction. Stockpiling of this soil at the mill site for reclamation following completion of mining is not considered mitigation, as additional disturbances of the hillside would be required to store the soil.

d. Tailing Impoundment

ASARCO has proposed to salvage topsoil to a depth of two feet over approximately 40 acres of the tailing impoundment area. It is suggested that all topsoil in the area proposed for the tailing impoundment be salvaged to its maximum usuable depth to allow ASARCO to better meet the stated goals of the reclamation plan.

5. Water Resources

a. Surface Waters

Those mitigating measures identified previously in the Soils sections for reducing the potential of erosion and sedimentation apply to the mitigation of surface water impacts.

Consciencious management of the mine and mill facilities, tailing pipeline, and tailing impoundment to reduce the potential for spills of toxic materials would be necessary to insure the continued existing water quality in the area.

b. Groundwater

Mitigation of well field water withdrawals accomplished proper water management to minimize water use and waste. Mitigation of tailings water seepage from the proposed tailing pond into Lake Creek could be accomplished by the management of the fine fraction of tailings to result in the sealing of permeable zones in the impoundment. Peripheral discharge systems as proposed by ASARCO would allow covering of permeable zones with a relatively impervious blanket of tailings material. By proper tailings management, infiltration of water from the tailings pond could be reduced, thereby reducing the need for water from Stanley Creek well field and the amount of water that would be added to Lake Creek.

c. Water Quality

Mitigation identified above would apply to maintaining the existing water quality. In addition, the instream biological and chemical/physical monitoring program contained in the tentative MPDES permit (Appendix H) is designed to assure maintenance of the existing water quality.

6. Flora

Mitigation of potential impacts to vegetation is linked closely with the successful mitigation of the impacts to the soils resource identified previously Those mitigating measures identified for the utility corridor are especially applicable. (Pages 411 to 413).

7. Aquatic Productivity

In addition to mitigation identified for the water resources, a continued aquatic biological monitoring program would help to insure the maintenance of the area's existing aquatic productivity.

The program would incorporate field surveys, "in-plant" (mine water) biological monitoring and bioassays and include all three of the major trophic levels of the Stanley-Lake Creek stream system.

The program would include:

*1) In Situ Fish Bioassay. This would be a 96-hour (4 day) assay modeled after the one performed by the Montana Department of Fish and Game in October 1977.

*2) Algal Assay. This would be the standard test for algal growth potential as prescribed by the Environmental Protection Agency ("Algal Assay Procedure: Bottle Test", National Eutrophication Research Program, Pacific Northwest Water Laboratory, Corvallis, Oregon, August 1971). Three replicates will be run for each site sampled.

3) Invertebrate Community Structure. This will be measured as it was for the ASARCO EIS by collection of five replicate Surber square-foot samples and one "qualitative" sample at each of the three sites sampled. Shannon-Weaver diversity ($\bar{d}$) and equitability (e) will be calculated as indicators of invertebrate community response to water quality conditions.

4) Periphyton Community Structure. This will also follow the procedure used for the ASARCO EIS baseline survey. A representative composite sample will be collected as each of the lower three sites and analyzed for the number and relative abundance of nondiatom algal genera and the percent relative abundance of diatom taxa. In excess of 500 cells will be counted for the diatom proportional county and resulting data will be used to calculate $\bar{d}$, e and various other indicators that may reflect environmental stress.

Stations would include:

1) Upper Stanley Creek above Adit Discharge (program 1 and 2).

2) Adit Discharge (program 1 and 2).

3) Upper Stanley Creek below Adit Discharge (SCI), (program 1 and 2).

4) Lower Stanley Creek below Fairway Creek (SC3), (bridge on main road to mine) (Program 1 through 5).

5) Lake Creek below Stanley Creek (LC1) (above pond) (program 1 through 5).

6) Lake Creek above Porcupine Creek (LC2) (below pond) (program 1 through 5).

Frequency of sampling would include:

1) March (pre-runoff, low temperature, rising light).

2) July (post-runoff, high temperature, high light).

3) November (near base flow, low temperature, low light).

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* Included in the tentative MPDES permit (Appendix H).

8. Terrestrial Fauna

A direct relationship exists between the amount of land disturbed as a result of development and the impacts of such disturbance upon wildlife. A conscientious effort to disturb as little land as possible would have the most immediate and long-lasting mitigating effects. Other mitigating procedures would include: 1) installation of bird boxes for cavity-nesting species in the vicinity of the proposed tailings pond, 2) enforcement of a maximum speed limit of twenty-five miles per hour from the mine site to highway 202 to help reduce vehicle-wildlife collisions, 3) minimal clearing of the utility corridor right-of-way to assure security cover for wildlife, 4) enforcement of firearms regulations which would prohibit the use of firearms for taking of wildlife on company property and along mine commuter access roads, 5) use of the roads on the north and south aspects of Mount Vernon limited to official use only, 6) prohibit recreational snowmobile use on company properties, and 7) consider mitigating measures identified through monitoring programs.

Some wildlife species, because of their vulnerability to human development or habitat alteration, could continue to be monitored in the area where development is pending. Such "key-species" would reveal a cause-and-effect relationship in response to alteration of their habitat. Therefore, key-species must occur in measurable numbers to lend themselves to monitoring techniques. On the ASARCO study area a number of key-species have been identified by the Montana Department of Fish and Game. If they were monitored prior, during and subsequent to mining development they would reveal a relative index to the change in the environment.

Ospreys may be considered a key-species in the Lake Creek valley because they are relatively abundant, easy to observe and are often victims of human development. Shooting of ospreys is often a primary cause of mortality; therefore the Lake Creek valley osprey population deserves special attention. Nine osprey nests were located on the study area during 1977-78 and because nests are often re-used and nesting ospreys are relatively easy to locate, a regular monitoring program could be instituted to monitor this osprey population. Standard techniques and survey periods for monitoring ospreys would involve conducting a yearly survey for nest sites with visits to the nests during critical periods to determine nesting success, fledging rates and population trends.

Mountain goats are another key-species on the ASARCO study area. Radio-telemetry monitoring of the goats which utilize the Spires and Ross Point areas would provide quantitative information regarding areas used during the summer by goats which winter on Mount Vernon (Spires) and Ross Point. The degree that these wintering groups mingle might also be established. Monitoring would reveal social hierarchy with respect to use of prime winter habitat and the degree to which this habitat limits the goat population. Monitoring would also reveal seasonal movements along the Mount Vernon-Spar Peak ridge.

Mountain lions are another key species on the ASARCO study area because their continued use of the Mount Vernon area may be contingent upon installation of the proposed utility corridor. The utility corridor would consist of the haul road, transmission line, slurry tailings pipeline, return water system and would be established along Stanley Creek. The area between Stanley Mountain and Keeler Mountain is used by mountain lions as a travel route. A radio-telemetry program designed to explore the effects upon lions of the proposed development, their adaptability to the development and possible use of alternate areas could be instituted through a joint agreement between ASARCO and the Montana Department of Fish and Game.

9. Endangered and Threatened Species

Endangered or threatened species occurring in the study area are provided with protection by the (U.S.) Endangered Species Act of 1973, and the (State) Nongame and Endangered Species Conservation Act of 1973. In addition, the Bald Eagle is provided protection by the Migratory Bird Treaty of 1918, and the Protection of Bald and Golden Eagles (1940).

Mitigation of direct or secondary impacts to those species occurring on the study area and considered endangered or threatened (page 221) could be aided by discouragement of development and other activities in the vacinity of areas used by these species. Educational programs could be implemented that would reduce vandalism and harrasment through better public understanding of the importance of these species.

The primary mitigation measures for the grizzly bear would be minimizing the bear/human encounters. This could be accomplished through 1) restricting access and non essential use in and adjacent to core grizzly habitat (Figure II-17), 2) scheduling essential work within the core area to seasons when the bear is not using the area, 3) through company policy restrict the availablity and use of fire arms at the mine and mill facilities, 4) commit the company to an education program on grizzly bear to give the worker a better understanding of the grizzly, 5) make the facilities less attractive to the grizzly by keeping the area clean and not planting large areas of grass and clover, 6) consider a company transporation system for mine and mill workers to reduce vandalism and harrasment of the grizzly during the periods they might be along the access road.

10. Employment and Population

Employment and population are not phenomean that in themselves require mitigation. However, they do affect the social environment. Mitigating measures related to the social environment are discussed in sections that follow.

This section will illustrate how employment and population might be changed if the level of production were varied. It seems only natural from the economic viewpoint of Lincoln County that it would be desirable to stretch out the life-span of the mining operation. Consequently, only the scenarious that extend the mining lifetime beyond 16 years (ASARCO's current projection) will be considered. It is assumed that the 3 year construction period cannot satisfactorily be extended.

The first scenario to be presented will extend the mining operation to 19 years. This number is selected because it is the ultimate production life which, according to the Bureau of Mines, will still provide an acceptable 15 percent rate of return on investment for the ASARCO Project.* Beyond this time period, the economic viability of the mine is highly questionable, based on 1977 costs of production and 1977 prices for copper and silver.

Using this 19 year cutoff, a daily rate of production of about 7,180 tons was estimated -- a reduction of about 15 percent from ASARCO's currently proposed rate. For the purposes of this section, this reduction must now be translated into a change in employment.

The second assumption regarding employment in this scenario is based on a conversation with the ASARCO Project Coordinator. A reduction in production cannot be equally transposed into a reduction in employment, because of certain economies of scale in production and the fact that some employment is not dependent upon production levels. In fact, it was stated that a 50 percent output reduction would result in only about a 25 percent labor reduction. Using similar reasoning, the 15 percent production decrease is equivalent to a 7.5 percent employment decrease.

A 7.5 percent reduction in mining employment at peak operation means about 23 fewer employees. This in turn means 287 mining employees in 1981 instead of 310.

Utilizing the new employment figures to project population in accordance with the methodology described in the impact of the mine section, a new population of 930 was calculated. A population of 10000 was the original estimate. So about 70 fewer people are estimated for Lincoln County under this scenario.

This reduction of 70 people must be divided between Troy, Libby, and Bull Lake Areas because of previous residence assumptions. The assumed percentage distribution of new residents for the Troy, Libby and Bill Lake Areas was 25, 35, and 40 percent respectively. This is translated into population levels of 18 less for the Troy Area, 24 less for the Libby Area, and 28 less for the Bull Lake Area, as compared with the scenario presented in the section on the population impact associated with the mine. Because of the impossibility of precisely estimating before the fact where people will choose to live, these population reductions may be statistical artifacts for one of more of the above identified areas.

For the purposes of illustration, the next scenario will assume that the mining lifetime if doubled, i.e., extended to 32 years or to the year 2012. It should not be inferred that such an extension is economically feasible. On the contrary, it is purely hypothetical and presented only to contrast the previous scenario.

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* Appendix T

In order to double the mine lifetime, it is assumed that daily production is halved. In turn with the logic presented in the previous scenario, it is assumed that employment is reduced by 25 percent. Then in 1981 the level of employment becomes 233 instead of 310 for the reduction of 77 employees.

This employment reduction can be converted to a decrease in population of 250 people, which can be allocated among the Troy, Libby and Bill Lake Areas using the residency percentage distribution assumptions. Hence, population is projected to be reduced by 63 in the Troy Area, by 87 in the Libby Area, and by 100 in the Bull Lake Area.

These reduced figures are relatively significant and soften the impacts associated with a growth in population. However, it should be emphasized that this scenario is illustrative only, and is likely not to be economically feasible.

11. Land Development

There are a number of regulations available to the city and county governments that could be used to control impact development so that land uses are compatible with each other as well as with the capability of the land. These regulations are discussed in Appendix P.

Lincoln County has adopted subdivision regulations that are administered by the Lincoln County Planning Board and the Lincoln County Board of Commissioners.

The City of Libby has an adopted zoning ordinance that governs development with the city limits. City zoning is administered by the City Council.

The City of Libby has adopted a comprehensive plan for an area extending approximately 4½ miles from the city limits. Extra-territorial zoning administered by the City and the County Planning Board can be extended to cover this area.

Basic planning data for the county has been collected by the county planning staff. Future planning efforts could be aimed at developing a county-wide land use plan that could be used as a basis for establishing county-wide zoning or county zoning districts covering specific areas.

At the present time, Troy does not have an adopted zoning ordinance. Such an ordinance could be adopted for the city limits. In order to extend zoning jurisdiction to cover an area within one mile of the city limits, a comprehensive plan would need to be developed and adopted. The city could adopt interim zoning if such a planning effort were to be initiated.

The Bull Lake area, including northern Sanders County could be controlled by county zoning, however; in order to implement county zoning, the Lincoln County Comprehensive Plan would have to be completed and Sander County would need to develop and adopt a county-wide comprehensive plan. An existing means for controlling development in both Lincoln and Sanders County are subdivision regulations that have been adopted by both counties. It would be advantageous for the two counties to jointly review their respective subdivision regulations to assure that the requirements for subdivision development will give adequate control for development in this particular area.

12. Quality of Life

There are only a limited number of mitigating actions that can be effectively taken that will directly deal with the identification and measurement of the quality of life. Indirectly, many of the mitigating measures taken in and across other categories will impact the area residents' feelings on the quality of life. Individual interpretation of what a quality life means to them is very subjective. The measurement of impacts of certain mitigating actions upon those qualities are also necessarily subjective. As a result of this subjectivity, specific plans of mitigation usually impact one element of quality of life one way while they can very easily impact the very next quality of life in precisely the opposite direction.

The nature of mitigating measures suggested in the following section are based on indications and answers given to questions while in the area interviewing people who are expecting to be subjected to the pressures of mining development.

Rarely will mitigating measures be viewed by a majority of residents as being in the same direction either positive or negative. Once it is decided to institute mitigating actions, extreme caution, care, and planning must be employed to minimize any damaging impacts that mitigating measures could bring. This will be especially true in the rural small town atmosphere of Troy, Montana. Interference by the ASARCO mining company is one thing, additional and compounding interference in the lives of the local residents by controlled organizations and agencies could be construed to be even more damaging to their quality of life than the effects of the mine.

Mitigation of some of the negative impacts on the area may be achieved through various steps. Gradual and controlled housing and business developments could help preserve the good qualities of the town. The county and city could initiate zoning regulations in order to control housing development. Also they could encourage screening the housing impacts by building in out-of-view areas. Constructing the roads where they could be considered less detrimental visually should be promoted. Encouragement and hiring of as many local individuals as possible to work in the mine would decrease the need for a great deal of additional land development for housing.

Mitigation that would serve to influence in a rapid fashion the overall economy of the area is the employment of those people who are indigenous to the area and especially those who are among the ranks of the unemployed. As mentioned earlier, preservice and inservice training programs could be instituted that would enable a greater percentage of local residents to be employed at the mine operation.

Public services can be enhanced through mine development, with mitigation efforts. Assistance from state level groups could be sought to properly plan for and develop adequate health and medical facilities to accommodate increased population expected to be added to the already present residential total. Still in the area of medical service, the ASARCO corporation could be encouraged to develop medical service specialized to their mining operation at the site of the mine. In addition, first aid training and corporate ambulance crews could be things that the corporation itself is encouraged to form.

Since much of the influx in population will be attributable directly to employment at the mine, the employees themselves, as well as the corporation can be a source for donated time and money to construct community service facilities such a new playground equipment or expanded parks throughout the residential areas. The corporate responsibility of mitigating social impacts brought about primarily by the development of the mine could be fostered. The quality of life can be enhanced through an increase in public services and an increase in the consideration of public services by planning bodies at all levels.

13. Social Services and Public Facilities

a. Housing

The Base Date Inventory prepared by the Lincoln County Department of Environmental Health and Planning (1975) included a detailed survey of housing needs and an analysis of housing problems in the county.

The housing survey indicates that 42.1 percent of the county residents were veterans who should be qualified for FHA or VA housing loans. Twenty-eight percent of the respondents indicated that financing, credit and loan availability was a major problem in financing housing; however, only 13.6 percent of the respondents have investigated the possibility of obtaining a Farmer's Home Administration loan for rural housing. Increased communication between agencies funding current housing programs and the citizens of the county would possibly improve the anticipated housing impact.

b. Water and Sewage

Troy is presently exploring the possibility of an EPA facilities planning grant. Once a facilities plan (sewer and water) for the area has been prepared, the community is eligible for a construction loan. The community could accelerate efforts to obtain this funding for improvements to the water system and construction of a centralized sewage system.

These improvements may encourage the development related population to locate in the town of Troy rather than on productive agricultural and forested land.

The location of impact development in areas that presently have community services would result in a more economical provision of services at less cost to the taxpayer.

c. Transportation

(1) Troy Street Improvements

In the city of Troy, the most constant impact of traffic generated by the mine would be on the route used by the ore trucks. This route begins at the loading site at the mine, follows an on-site company haul route to Highway 202, goes north on 202 to Highway 2, follows Highway 2 to Troy where the route turns right onto Yank Avenue, ending at the Burlington Northern Railroad Loading site.

The section of Yank Avenue, which is currently a local street, may require reconstruction in order to support the 20 ton ore trucks that will use the street. This street functions as a north-south collector.

Other local street improvements within the Troy City limits may become feasible as residential development takes place. These may be funded by special improvement districts, federal off-system funds, gas tax revenue or combinations of these sources.

(2) Highways

Impact area traffic volumes would remain well within the capacity of the existing system, however, traffic characteristics will contribute to already existing safety problems. The mix of home-work traffic with slower recreation vehicle traffic during the peak tourist periods would create passing problems on curves and hilly sections of Bull Lake Road and U.S. Highway 2.

Improvement priorities established by the Montana Highway Department for U.S. Highway 2 will take projected volume increases and high accident areas into account.

The following mitigating measures identified by the Montana Department of Highways could be implemented to facilitate traffic movement along Route 202 and U.S. Route 2:

1) scheduling of ore shipments to avoid convoys,

2) maintaining ore trucks to reduce noise,

3) support programs which would limit commuter traffic, such as bus service from Troy to Libby, and bus service from Troy to the mine site, and incentives for employee car pooling,

4) scheduling shipments to avoid peek traffic hours,

5) using trucks powerful enough to maintain speed on hills and instructing drivers to allow other vehicles to pass, and

6) supporting local bus service through employee rebates.

All areas disturbed by the construction of the mine access road approach the Route 202 would be reseeded to adaptable grasses or a combination of adaptable grasses and legumes as required by Section 32-2412, R.C.M. 1947.

(3) Forest System Roads

Mitigation measures on forest system roads would be primarily for public safety due to increase use by recreational traffic. These measures would include additional regulatory and hazard warning signs, dust oiling, and possible oiled surfacing.

Proper maintenance and hazard signing of the mine access road, to reduce the potential for safety hazards between the public and mine vehicles, would be the responsibility of ARARCO. Enforcement of this responsibility on that portion of the access road located on National Forest land would rest with the Kootenai National Forest.

d. Schools and Student Transportation

(1) Schools

The Libby and Troy schools have sufficient capacity to meet the needs of the impact population based upon the estimated distribution. If there is more impact related development than anticipated in the Troy and Bull Lake areas, the Troy school district may not have sufficient capacity. One solution to this would be to bus students from the Bull Lake area into Libby. However, winter road conditions and the safety hazards of the section of U.S. Highway 2 from Bull Lake Road to Libby would make this solution undesirable.

The most feasible solution would be expansion of the Troy school system funded by bonds approved by voters in the district.

Effective July 1, 1978, the bonding capacity of a municipality will be 18 percent of the taxable value. Based on the City of Troy budget of June 30, 1978, the taxable value was $465,744.00. This results in a general obligation bonding capacity of $83,834.00. Outstanding bonds amount to $21,345 leaving a bonding capacity of $62, 489 to be used to meet future needs that could be funded by general obligation bonds.

(2) Student Transportation

Development in the Bull Lake area would require additional transportation. Addditional funding for this area would be available through the Superintendent of Public Instruction, under the funding program currently in effect.

14. Recreation

The impacts on recreational opportunities could be reduced by proper planning and some specific mitigation measures. The present developed recreation facilities could be expanded and the facilities to handle increased use. Additional recreational facilities could be developed to handle the increased use. Company contributions for construction of some recreational facilities should be encouraged.

Efforts should be made to enhance the opportunities in areas less frequently used, spreading the impact so that one area is not over used and overcrowded while another remains relatively unused. ASARCO can also help in this area by assisting in educating mine workers unfamiliar with the area regarding animal habits, migration, and the overall wildlife and land use situation.

Some residents in the area believe increased population will have a positive effect on local organized sports programs by increasing the number of available participants. School athletics are highly competitive and an important form of recreation in the Troy and Libby areas.

The City of Libby recently defeated a bond issue to construct a new swimming pool; however, Libby has been active in obtaining Bureau of Outdoor Recreation funds for parking and recreation facility development.

New subdivisions would be required to dedicate well located developable land for parkland as required by the county subdivision laws.

The City of Troy recently applied for a Bureau of Outdoor Recreation Grant to improve the existing ball park and play area near W.F. Morrison Elementary School. The grant will be used to improve the ballpark, install fencing and to carry out other site improvements.

15. Public Safety

Law enforcement agencies in the area have actively participated in schooling and funding programs available through the Law Enforcement Assistance Administration administered through the State Department of Justice. Concentrated Employment Training Act funds have also been used to fund additional personnel.

The County Sheriff, and Troy and Libby police departments could use these funding sources for additional personnel and equipment that would be necessary to meet the mine impact needs.

Funds for improvements for rural fire departments are available through the State Forestry Department.

16. Social and Welfare Services

Additional personnel would be required in each of these areas to serve the needs of the mine impact population. The mine impact would substantially increase the demand for housing assistance as well as other programs. Planning for expansion of these services could be started well before the anticipated needs occur.

17. Health Services

Health services including hospital and ambulance within the impact area are sufficient to serve the impact population without major improvements. Some respondents to the quality of life interviews believe that medical care would improve as a result of increased population.

18. Visual Resource

Mitigating measures relating to the visual resource would be required for all mine related facilities. The design and location of all the facilities would attempt to use topography, vegetative screening, size, shape and color to screen or blend the facility into the landscape. Disturbed areas would be promptly reseeded and restored to vegetation. Areas that were purmanently cleared of existing vegetation for the life of the mining project could be shaped to blend in with adjacent natural openings.

Mine related commercial and residential development in the Lake Creek and Bull River Valleys should be encouraged to use topography and vegetation to screen or blend the development into the surrounding landscape.

Mitigating measures for the visual impacts of the proposed transmission line have been developed by the Montana Department of Natural Resources and Conservation and are contained in Appendix V.

V. ALTERNATIVES TO THE PROPOSED ACTION

A. Introduction

ASARCO has made separate applications, as required, to the Commissioner of Montana Department of State Lands and the Supervisoe Kootenai National Forest for permission and approval of a plan of operation to develop and mine a copper-silver ore body near Mr. Vernon in Northwest Montana.

The ore body is on patented land. Some of the mine development and all of the milling operation will take place on federally owned land. The tailings impoundment and part of the tailings slurry line will be on privately owned land.

Given the existing dual regulatory and approval authority regarding the present proposals, the viable and reasonable alternative courses of action available to state and federal agencies for the mine proposal differ significantly. The following discussion of alternatives recognizes the individual responsibilitiers of the Federal and State governments, and the various alternatives available to the Secretary of Agriculture and to the State authorities.

Alternatives that apply generally to the development of the mineral resources in Montana include those of an administrative nature as well as those involving alternate mining and reclamation plans, technological alternatives, and reduced consumption of energy.

B. Administrative Alternatives Available To The Federal Government

Alternatives available to the Federal government for the proposed action are limited under the existing laws and regulations. The Secretary of Agriculture can:

1. Approve the Operating Plan as Submitted

This alternative certifies that the plan merits environmental standards and any administrative constraints.

2. Approve the Operating Plan as Submitted With Mitigating Measures

This alternative requires that the proponent observe a number of stipulations to assure that the operation meets 11 environmental protection standards and administrative constraints.

3. Require Modification of the Operating Plan to Meet Environmental and Administrative Constraints

This alternative would require a substantial change in the proposed operating plan to meet environmental and administrative constraints. Modification could include changes in the mining and milling methods and/or location of the proposed operation.

4. Require Both Modification of the Plan of Operation and Mitigating Measures

This alternative would require both a change in the plan of operation and additional stipulations for operation of the proposed development. Generally modification would cover the mining and milling method and location of the facilities. The stipulation would cover the operation phases of the development. This alternative generally presents the best way to insure compliance with environmental and administrtive constraints and have the benefit of the concerns and inputs of the public and federal, state and local government agencies.

5. Disapprove the Plan of Operation

This alternative would disapprove the plan of operation as not workable under the environmental and administrative constraints. The plan would be returned stating the reasons for disapproval and request the proponent submit a new plan that will meet the environmental and administrative constraints.

Alternatives 2, 3 and 4 would require the operator to finish a reclamation bond (252.8(q) and 252.13) Appendix X. The amount of the required bond would be determined by estimating the cost of stabilizing, rehabilitation and reclaiming the area of operations. During the life of the project should the plan of operation be modified the bonding requirement will be reviewed and adjusted to conform to the plan as modified.

B. Administrative Alternatives Available To State Agencies

1. Department of State Lands

a. Approval of the Operating Permit for the Life of the Operations

Section 10.(50-1210)(c)(2) of the Hard Rock Law provides that:

The operating permit shall be granted for the period required to mine the land covered by the plan and shall be valid until the surface or underground mining authorized by the permit is completed or abandoned, unless the permit is suspended or revoked by the board as provided in this act. The operating permit shall provide that the reclamation plan may be modified by the board*, upon proper application of the permittee, or department, after timely notice and opportunity for hearing, at any time during the term of the permit and for any of the following reasons:*

(a) to modify the requirements so they will not conflict with existing laws;

(b) when the previously adopted reclamation plan is impossible or impracticable to implement and maintain;

(c) when significant environmental problem situations are revealed by field inspection.

(1) Performance Bond

Section 11.(50-1211) of the Hard Rock Law provides that:

The applicant shall file with the department a bond payable to the state of Montana with surety satisfactory to the department in the penal sum to be determined by the department of not less than two hundred dollars ($200) nor more than twenty-five hundred dollars ($2,500) for each acre or fraction thereof of the disturbed area, conditions upon the faithful performance of the requirements of this act and the rules of the board. In lieu of such bond the applicant may file with the board* a cash deposit, an assignment of a certificate of deposit, or other surety acceptable to the board.* Regardless of the above limits, the bond shall not be less than the estimated cost to the state to complete the reclamation of the disturbed land. A public or governmental agency shall not be required to post a bond under the provisions of this act. A blanket performance bond covering two (2) or more operations may be accepted by the board.* Such blanket bond shall adequately secure the estimated total number of acres of disturbed land. When determined by the department that the set bonding level of a permit or license does not represent the present costs of reclamation, the department may modify the bonding requirements of that permit or license.*

No bond filed in accordance with the provisions of this act shall be released by the department until the provisions of this act, the rules adopted pursuant thereto and this reclamation plan have been fulfilled

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* Board of Land Commissioners, or such state employee or state agency as may succeed its powers and duties under this act.

(2) Suspension of Permit

Section 25.(50-1225) of the Hard Rock Law provides that:

If any of the requirements of this act or the rules or the reclamation plan have not been complied with within the time limits set by the department or board or by this act, the department shall serve a notice of noncompliance on the licensee or permittee, or where found necessary, the commissioner shall order the suspension of the permit. The notice or order shall be handed to the licensee or permittee in person or served by registered mail addressed to the permanent address shown on the application for a permit. The notice of noncompliance shall specify in what respects the operator has failed to comply with this act, the rules or the reclamation plan. If the licensee or permittee has not complied with the requirements set forth in the notice of noncompliance or order of suspension within the time limits set therein the permit may be revoked by order of the board* and the performance bond forfeited to the department.*

b. Denial of the Operating Permit

Section 14.(50-1214) of the Hard Rock Law provides that:

A permit may be denied for any of the following reasons:

(A) The plan of development, mining, or reclamation conflicts with the state water and air purification standards;

(B) The reclamation plan does not provide an acceptable method for accomplishment or reclamation as required by this act.

A denial of a permit shall be in writing and state the reasons therefore.

In addition, Section 15.(50-1215) provides that:

A permit may be denied and returned to the applicant with a request that the application be resubmitted with a different plan for reclamation. The person making application for a permit may than resubmit to the board a new plan for reclamation.*

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* Board of Land Commissioners, or such state employee or state agency as may succeed its powers and duties under this act.

2. Department of Natural Resources and Conservation

a. Approval of Application for Beneficial Water Use Permit

Section 885 of the Water Use Act provides that:

The department shall issue a permit if:

(1) there are unappropriated waters in the source of supply:

(a) at times when the water can be put to the use proposed by the applicant;

(b) in the amount the applicant seeks to appropriate; and

(c) throughout the period during which the applicant seeks to appropriate, the amount requested is available;

(2) the rights of a prior appropriator will not be adversely affected;

(3) the proposed means of diversion or construction are adequate;

(4) the proposed use of water is a beneficial use;

(5) the proposed use will not interfere unreasonably with other planned uses or developments for which a permit has been issued or for which water has been reserved;

(6) an applicant for an appropriation of 10,000 acre-feet a year or more or 15 cubic feet per second or more proves by clear and convicing evidence that the rights of a prior appropriator will not be adversely affected.

Section 886.(1) further states that:

The department may issue a permit for less than the amount of water requested, but in no case may is issue a permit for more water than is requested or than can be beneficially used without waste for the purpose stated in the application. The department may require modification of plans and specifications for the appropriation or related diversion or construction. It may issue a permit subject to terms, conditions, restrictions, and limitations it considers necessary to protect the rights of other appropriators, and it may issue temporary or seasonal permits. A permit shall be issued subject to existing rights and any final determination of those rights made under this act.

b. Denial of Application for Beneficial Water Use Permit

Section 880.(3) of the Water Use Act provides that:

> *The department may cease action upon an application for a permit and return it to the applicant when it finds that the application is not in good faith or does not show a bona fide intent to appropriate water for a beneficial use. An application returned for any of these reasons shall be accompanied by a statement of the reasons for which it was returned, and there shall be no right to a priority date based upon the filing of the application. Returning an application pursuant to this subsection shall be deemed a final decision of the department.*

c. Issuance of a Provision Permit

Section 880.(4) of the Water Use Act provides that:

> *A permit issued prior to a final determination of existing rights is provisional and is subject to that final determination. The amount of the appropriation granted in a provisional permit shall be reduced or modified where necessary to protect and guarantee existing rights determined in the final decree. A person may not obtain any vested right, to an appropriation obtained under a provisional permit, by virute of construction of diversion works, purchase of equipment to apply water, planting of crops, or other action, where the permit would have been denied or modified if the final decree had been available to the department.*

d. Certificate of Environmental Compatability and Public Need

Approval or denial of the Certificate of Environmental Compatability and Public Need for construction of the proposed 115 Kilovolt transmission line would be required to meet the criteria contained in the Montana Major Facilities Siting act. These criteria will be discussed in detail in the draft EIS for the proposed transmission line currently being produced by the Department of Natural Resources and Conservation, and anticipated to be issued later this year.

3. Montana Department of Highways

a. Approval, Modification, or Denial of an Approach Permit

Criteria for approval, modification, or denial of an Approach Permit are contained in 18-2.6AI(1)-S615 and 5635. In particular:

> *The Field Maintenance Bureau Personnel, in conjunction with the Division Traffic Engineer, are delegated authority to approve curb cuts, public and private approaches serving businesses, residences, and agricultural uses in rural and urban areas without further consulation if the traffic conditions are not conjected. In conjected areas, usually urban situations in the Field Maintenance Personnel and Division Traffic Engineer can request the Manager, Traffic Design Unit, Helena, for further technical aid. If this is the case, the approach should be scaled onto existing plan and profile sheets showing the highway right-of-way and sent to Helena.*

4. Montana Department of Health and Environmental Sciences

a. Water Quality Bureau

(1) Mine Portal Discharge

(a) Denial of an MPDES Permit for the Mine Portal Discharge

Under Section (6)(b) of rule MAC 16-2.14(10)-S14460 ("Montana Pollutant Discharge Elimination System"), the Department of Health and Environmental Sciences may deny issuance of an MPDES permit based on the applicants apparent noncompliance with technical requirements outlined under Sections (5)(a)(i) through (5)(a)(vii) and following Department procedures outlined under Sections (5)(b) through (5)(i) of the same rule.

(b) Issuance of an MPDES Permit for the Mine Portal Discharge

Under Section (6)(a) of rule MAC 16-2.14(10)-S14460, the Department of Health and Environmental Sciences may issue an MPDES permit subject to conditions and terms prescribed in Section (7) and following Department procedures outlined under Sections (5)(b) through (5)(i) of the same rule.

(2) Short-term Construction Activities

(a) Authorization Under Prescribed Conditions

Under Section (6)(g) of rule MAC 16-2.14(10)-S14480 ("Water Quality Standards"), the Department of Health and Environmental Sciences may authorize, under conditions it may prescribe short-term activities that will cause turbidities to exceed those allowed by water quality criteria outlined in Section (5) of the same rule, provided that such turbidities are unavoidable.

NOTE: The Montana Water Quality Standards do not specifically authorize denial of short-term activities causing unavoidable turbidities in excess of the criteria. The standards do say (Section (6)(g)) that "no wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause turbidities to exceed those allowed by specific water quality criteria." Short-term activities conditionally approved by the Department of Health and Environmental Sciences are exceptions.

b. Air Quality Bureau

(1) Approval of the Construction Permit

MAC 16-2.14(1)-S1400(3) of the departmental rules and regulations adopted pursuant to the Montana Clean Air Act (Title 69, chapter 39, R.C.M. 1947) provides that:

> *The application for a permit shall be accompanied by plans, specifications, and such other information as the administrator deems necessary except that the administrator may dispense with the submission of plans and specifications upon prior written agreement.*

S1400(11) further states that:

> *Before any article, machine, equipment or other contrivance described in this regulation may be operated or used, a written permit shall be obtained from the administrator. No permit to operate or use shall be granted by the administrator for any article, machine, equipment or contrivance described in this regulation, constructed or installed without authorization as required in this regulation, until the information required pursuant to these regulations is presented to the administrator and such article, machine, equipment or contrivance is altered, if necessary, and made to conform to the standards set forth elsewhere in the standards and regulations formulated under authority of the Clean Air Act of Montana.*

(2) Denial of the Construction Permit

MAC 16-2.14(1)-S1400(12) provides that:

The administrator shall deny an authority to construct, or permit to operate or use, except as provided in this regulation, if the applicant does not show that every article, machine, equipment or other contrivance, the use of which may cause the issuance of contaminants, or the use of which may eliminate or reduce or control the issuance of air contaminants, is so designed, controlled, or equipped with such air pollution control equipment, that it may be expected to operate without emitting air contaminants in violation of standards and regulations formulated under authority of the Clean Air Act of Montana.

In acting upon a permit to operate, if the administrator or a member of his staff finds that the article, machine, equipment or other contrivance has not been constructed in accordance with the authority to construct, he shall deny the permit to operate. The administrator shall not accept any further application for permit to operate the article, machine, equipment, or other contrivance so constructed until he finds that the article, machine, equipment or other contrivance has been constructed in accordance with the authority to construct.

(3) Conditional Approval of the Construction Permit

MAC 16-2.14(1)-S1400(13) provides that:

The administrator may issue an authority to construct or a permit to operate or use, subject to conditions which will bring the operation of any article, machine, equipment or other contrivance within the standards of this regulation, in which case the conditions shall be specified in writing. Commencing work under such an authority to construct or operation under such a permit to operate shall be deemed acceptance of all the conditions so specified. The administrator shall issue an authority to construct or a permit to operate with revised conditions upon receipt of a new application, if the applicant demonstrates that the article, machine, equipment or other contrivance can operate within the standards of this regulation under the revised conditions.

(4) Renewal of Construction Permit

MAC 16-2.14(1)-S1400(7) provides that:

> *(7) If the construction, installation or alteration for which a permit has been issued is not completed within two years from the date of issuance of the permit, a renewal of the permit shall be required.*

D. Alternative Technology

The U.S. Bureau of Mines Western Field Office evaluated the proposed plan of operation at the request of the Kootenai National Forest. Their report is included in Appendix T. The Bureau of Mines evaluated the proposed methods of mining milling and tailings impoundment as to their feasibility in this situation. They also evaluated alternative methods of mining, milling and tailings disposal for this type of ore body. Their findings are as follows:

1. Mining Method

The mining plan proposed by ASARCO is a standard room-and-pillar system, the most common large-scale underground mining method in use today in the United States. It is, therefore, a well-tested method which can be applied with a high degree of confidence under appropriate conditions.

The Troy deposit, is amenable to the proposed room-and-pillar system. The method has many environmental, technical, and economic advantages compared to alternative methods.

In search for viable alternatives to the proposed mining method, all of the standard mining systems were examined for applicability to the Troy deposit. These systems are as follows:

a. In Situ Leaching

The term "in situ leaching," as used here, means the chemical extraction of metal values from ore without removal of the ore from, or disturbance in, its original geologic setting, other than fracturing in some way to improve the ore's permeability. It involves percolating fluids through an ore body to dissolve the ore minerals and carry the metal values in solution to a collection area. The fluids are then processed to cause precipitation out of solution.

The low cost and low environmental impact of in situ leaching warrant its consideration for any new mining operation. However, the Troy deposit's low permeability, tabularity, horizontal orientation, depth, and dual metal character make it a highly unlikely candidate for a successful in situ leaching operation.

b. Sublevel Caving

Sublevel caving is a mining system whereby sublevel drifts are driven through the orebody at regular vertical and horizontal intervals. These drifts provide access to the orebody for drilling and blasting to induce caving. As in block and panel caving, surface subsidence results from such an operation.

Probably the Troy Project wallrocks would not cave properly, and the relatively flat dip of the orebody would make dilution control difficult, and greatly reduce mining efficiency at the contact areas. Therefore, sublevel caving should not be considered a viable alternative mining method for the Troy Project.

c. Block Caving and Panel Caving

Block and panel caving systems exploit the weaknesses inherent in a rock mass by using the force of gravity to effect both the breakage of ore and its movement to loading points.

Caving of a block or panel of ore is made possible by undercutting and removing at a depth the natural support for the rock in a large controlled lateral area. The overlying rock then fails in tension and falls into the void of the undercut, which must have a lateral area large enough to prevent the formation of natural arches. After caving begins, the broken rock is drawn off through an arrangement of ore passes at a rate that allows continuous caving. As caving progresses, a large subsidence area develops at the surface.

Based on a visual examination of the ore in place and analysis of the rock mechanics test data presented to us, we conclude that the Troy Project rock is too competent to cave properly. In addition, the deposit does not have sufficient vertical dimension to pay for the extensive development work which would be required beneath the ore body to initiate a caving operation. For these reasons, block or panel caving cannot be considered a viable alternative mining method for the Troy Project.

d. Sublevel Opening Stoping

Sublevel open stoping entails providing access to the ore body at various subintervals between main haulage levels in order to drill and blast the intervening ore. Stope drilling is carried out from drilling drifts on the sublevels, and the ore is blasted in slices towards an open face. The blasted ore gravitates to the bottom of the stope and is collected through drawpoints. When properly utilized, the system results in no surface subsidence.

The angle of repose of broken Troy Project ore would be about 35 degrees to 40 degrees. The maximum dip angle of the Troy Project deposit is about 8 degrees. The dip on the footwall would, therefore, not be sufficient to allow blasted ore to gravitate freely to the drawpoints. The method, therefore, would not be successful if applied to the Troy deposit.

e. Shrinkage Stoping, Cut and Fill Stoping, and Square Set Stoping

These systems are all designed to handle the irregularities and ground support conditions of vein mining. They are flexible and selective, but expensive and typified by low productivity. The conditions for which they were designed do not exist at the Troy Project and their high costs eliminate any possibility of using them for such a low grade deposit.

f. Surface Mining

Surface mining methods are technically feasible for the Troy orebody. However, most of the deposit is too deeply buried to make such a venture economically feasible. Surface mining would also have a considerably greater environmental impact than the proposed method. More land area would be disturbed for the pit, waste dumps, and haul roads. Blasting and hauling of both ore and overburden would cause considerable noise and dust, and more energy would be consumed in breaking and removing overburden. Surface mining, therefore, should not be considered a viable alternative mining method for this deposit.

g. Modifications of the Room-and-Pillar System

Innumerable modifications of the room-and-pillar method could be proposed for the Troy Project. These modifications would probably not result in any significant variation in environmental disturbance from the proposed system. Any proposal resulting in pillars with a ratio of the least pillar dimension to pillar height that is less than one (1) should be very carefully examined because instability is introduced when this ratio is less than one (1).

2. Milling Method

Modern day copper mining operations generally produce low-grade ore, normally within the range of 0.4 to 1.0 percent copper. Because of resultant uneconomic transportation costs, these ores must be reduced on site as much as possible. On-site processing, or milling, reduces substantially the amount of material which would otherwise be transported to the smelter for further processing. This sizable reduction of the tonnage of material to be shipped and the attendant reduction of transportation charges make mining of these reserves economically sound. The flotation mill proposed for the Troy project will produce a concentrate which will be only 2 percent of the amount of original ore mined.

Technologically, the flotation method proposed for the Troy Project mill is well established as the best means for concentrating the contained copper ore minerals. More specifically, this plant will process the ore in several stages (crushing and grinding, flotation, concentrate filtering and drying, and tailings disposal) all of which are standard in the industry today. These processing stages have well established technologies and it is improbable that any significantly beneficial variation, either economically or environmentally, can be proposed.

a. Direct Shipping of Ore

Shipping of the ore directly from the mine to the smelter without the intermediate milling step would eliminate the mill facility at the mine site and the tailings pond near Lake Creek. It would, however, result in considerable haul-truck traffic, with enormous consumption of energy for hauling and smelting. For economic reasons alone, this alternative cannot be seriously considered. The cost of hauling and smelting such large amounts of low-grade ore would greatly exceed the value of the ore.

b. Leaching

Leaching can be roughly classified into three categories--in situ, dump, and heap leach. Dump leach is a method normally employed to extract copper from low-grade (_0.3 percent copper) waste that is moved during normal mining operations. This method allows for the partial recovery of a resource which would otherwise be completely lost.

Dump leaching of the amount of material which will be involved in the Troy Project would necessitate the stripping of large areas on which to place the dumps; the time required for continual leaching indicates that the dumps would have to be maintained without reclamation for at least 10 years, and finally, unless excessively costly precautions are taken, the leach liquors would always pose a major threat to the quality of the local groundwater.

Heap leaching is much like dump leaching except that large asphalt pads are constructed upon which the ore is placed, and a somewhat stronger acid solution is used. For economic operation, this process requires that the copper be contained in the form of acid-soluble, oxid minerals to allow a reasonable cycle time for each pad. The sulfide ore of the Troy Project does not meet this requirment; therefore, either dump or heap leaching is not an economic alternative to the proposed milling method.

c. Gravity Concentration

Gravity concentration is the beneficiation process which would have been employed if the mill were constructed in the early 1900's, prior to the development of flotation. This method takes advantage of density differences to separate the ore minerals from the gangue minerals, which are normally lighter. The devices employed (tables and jigs) are most effective when the grains of valuable minerals are coarse. Because the chalcopyrit and other copper minerals are fine-grained at the Troy Project, gravity concentration would be marginally effective in separating the ore and gangue minerals.

An additional consideration, and one upon which the economic decision would be made, is the much lower copper recovery characteristic of gravity as opposed to flotation mills. Only 40 to 60 percent recovery of the contained copper values can be contemplated in a gravity mill, whereas 90 percent recovery (in a substantially higher grade concentrate) can be anticipated in a flotation mill.

d. Milling at a Remote Location

A millsite location environmentally more desirable than the proposed site might be found. However, if this were done, haulage costs would become a prime consideration in determining economic feasibility. Financial analyses were performed for theoretical operation with all conditions similar to those proposed except for varying haul distances. (See Appendix T). This analysis shows that as distance between mine and mill location increases, economic justification for the venture rapidly decreases.

e. Underground Milling

ASARCO is considering the possibility of relocating a portion of the surface plant underground. If feasible, it would involve relocating the secondary crusher and concentrator underground as shown in Figure I-15. The process remains the same and the general plan arrangments and adit locations are subject to the same variable previously mentioned.

3. Tailing Impoundment

Generally the proposed site appears to be well-suited for tailings disposal and the preliminary design is adequate. The USBM, after review of the proposed tailings impoundment, listed comments and suggestions for consideration in the final design of the facility (USBN Report Appendix T).

Dump, heap, and in situ leaching, direct chipping of ore, and milling at a remote location, which are discussed as alternatives to the proposed mining and milling methods would all result in either elimination or displacement of the tailings disposal site. (See USBM Report P. 5-8, Appendix T).

In 1974 ASARCO contracted with Dames and Moore to do geophysical evaluation work on the proposed tailings impoundment area and an alternate site in the same general area as the proposed facility. As a result of this preliminary investigation the alternative site was dropped from consideration. (Dames and Moore, Report of Geophysical Studies Proposed Tailing Ponds Near Troy, Montana, 1974).

4. Replacement of Tailing In Mine

Hydraulic placement of tailings in mined out portions of stopes is practiced in many vein mines where the tailings can be used to advantage in the mining opertion. The dewatered tailings provide a working surface for continued drilling, blasting, and mucking in the stope, and they prevent sloughing of large rocks from the stope walls. The cost of this procedure is warranted where ore grade is high. The system replaces other more costly procedures such as square-set timbering, and it reduces the amount of surface storage required.

Originally tailings were thought to provide considerable ground support; however, it is now known that the strength of the tailings is so minor that they provide little support. Methods are being developed to improve the support capabilities of tailings, such as electrokinetic dewatering and addition of cement; however, their strength remains minor even after these techniques are applied. What little strength exists is largely a result of confinement.

At the Troy Project, no technical advantage for the underground operation would be gained by storage of tailings in the mine. The working surface is not necessary; no ground support can be anticipated, particularly because of the lack of confinement; and any advantage the tailings might provide in the way of preventing sloughing would be largely negated by the time lag which would be required between blasting and placement of tailings.

With some modificaion in mine design, some tailings might be stored underground if the objective were to reduce surface storage requirements. The wide square rooms would have to be modified to long narrow openings to reduce the size and number of bulkheads required. Production scheduling would have to be modified to provide inactive mined out areas for filling. Removal of the tailings water from the mine would be a minor problem since no pumping would be required.

If an underground storage system were initiated, about 60 percent of the tailings would still have to be stored on the surface as a result of expansion of material, inability to fill stopes to the top, and inability to schedule tailings placement and mine production with sufficient efficiency to fully utilize all available storage space.

Underground storage might improve the possibilities for a successful pillar recovery program, resulting in improved resource recovery.

5. Extending the Life of the Mine

It is technically feasible to extend the life of the mine beyond the time frames proposed by ASARCO. The question on the extended life of the mine becomes one of economical feasibility to do so.

The U.S. Bureau of Mines used their mine simulation computer program using varying production rates to extend the life of the mine. For all production periods greater than 19 years the estimated rates of return on the investment were less than 15%. Extended life beyond 19 years was considered economically questionable (USBM 1977 P.3-5, Appendix T).

6. Development of Alternative Sources of Energy

a. On-Site Generation

ASARCO explored the possibility of on-site power generation with diesel generators and found the cost to be about four times greater than hydro-electric power. Besides prohibitive operating costs the turbine generation would be noisey and discharge pollutants to the atmosphere.

Sufficient hydrologic head is not available to produce on-site hydroelectric power capable of meeting the power requirements of ASARCO.

b. Alternative Transmission Line Size and Routing

An analysis of alternative transmission line voltages and alternate line routes, as well as a detailed consideration of alternative on-site power generation, will be contained in the EIS currently being produced by the Department of Natural Resources and Conservation as mandated by MEPA and the Montana Major Facilities Siting Act.

VI. CONSULTATION AND COORDINATION WITH OTHERS

A. Development of Statement

This environmental impact statement was prepared by a Federal-State task force under the coleadership of the Kootenai National Forest and the Montana Department of State Lands. Major inputs were provided by the following:

Federal Agencies
- U.S. Bureau of Mines
- U.S. Forest Services

State Agencies
- Montana Department of Natural Resources and Conservation
- Montana Department of Highways
- Montana Department of Health and Environmental Sciences
- Montana Department of Fish and Game
- Montana Department of Community Affairs
- Montana Department of State Lands

Private Organizations
- Olson & Elliot and Associates
- Daily-Peccia and Associates
- T.A.P. Inc.
- Western Technology and Engineering Inc.

Additional participation and assistance were obtained from many sources. ASARCO Inc., provided data and information on their proposed activities, as well as numerous visual aids. Copies of the 115 Kilovolt transmission line application were supplied by Northern Lights Inc. Officials and employees of city and county governments in the Troy-Libby-Noxon area also provided data and assistance. Comments of residents of the area and others were especially helpful in the preparation of this document.

B. Review of Statement

In accordance with U.S. Council of Environmental Quality and Montana Department of State Lands rules and guidelines, copies of the draft statement are being made available to the public for their comments and suggestions.

GLOSSARY

Algae: small, often microscopic aquatic plants that lack true leaves, stems and roots.

Aufwuchs: generally synonymous with Periphyton, but also including a number of very small animals that inhabit the slime layer.

Autotrophic: describing organisms that make their own food, i.e., plants with chlorophyll.

Autotrophic Index: the ratio of biomass to chlorophyll in a plant community.

Bacteria: small, usually microscopic plants that lack chlorophyll and results in the decomposition of dead plants and animals.

Benthic (Benthos): relating to organisms living upon or within the bottom of a lake or stream.

Biomass: the organic fraction of a biological community.

Bryophytes: mosses; in this case, aquatic mosses.

Carotenoids: a yellow or orange pigment found in most plants that is usually masked by chlorophyll.

Chlorophyll: the green pigment in most plants capable of using sunlight in converting raw materials (water and carbon dioxide) into carbohydrates.

Chlorophyta: the division of algae having predominantly green pigments.

Chrysophyta: the division of algae having predominantly yellow-green pigments; includes the diatoms.

Community: the collection of plants and/or animals occupying an ecologically distinct area of the earth's surface.

Cyanophyta: the division of primitive algae having predominantly blue-green pigments and lacking a true nucleus and a cell wall.

Diatom: a kind of one-celled algae encased in a glass compartment (frustule); often dominates the periphyton in Montana streams.

Diversity: a measure of the genetic richness of a community of organisms reflecting the number of different species in relation to the number of individuals in a sample.

Equitability: a measure of the closeness a community of organisms comes to the theoretical maximum diversity computed as though all species were equally abundant.

Eutrophication (Eutrophic): the process or condition whereby a lake or stream is overly enriched with nutrients resulting in excess growth of aquatic plants and associated problems.

Heterotrophic: describing organisms that live on other organisms, i.e., animals and plants without chlorophyll.

Lotic: relating to flowing water.

Macroinvertebrates: aquatic animals without backbones tht live on or within streams and lake bottoms and are visible to the unaided eye.

Macrophyte: an aquatic plant visible to the unaided eye and possessing leaves, stems and roots or structures analogous to these.

Micronutrients: elements dissolved in water that are required in very small amounts for the growth of aquatic plants, e.g., boron, manganese, zinc, cobalt, copper, molybdenum and iron.

Oligotrophic: a condition whereby a lake or stream has low nutrient concentrations, resulting in very limited growth of aquatic plants.

Periphyton: the assemblage of algae either attached to, motile over or resting upon a submerged substrate; the slime covering the rocky bottoms of streams.

Pheophytin: a pigment resulting from the degradation of chlorophyll.

Phytoplankton: the plant or algal component of the plankton.

Plankton: small, often microscopic plants and animals that live suspended in the open water of lakes, reservoirs and large rivers.

Protozoa: microscopic, unicellular animals.

Productivity (Production): the rate of accrual of plant or animal matter per unit area or volume of water.

Rhodophyta: the division of algae having predominantly red pigments.

Seston: particulate matter suspended in water.

Stenothermal: occurring over a temperature range of no greater than 5°C.

Taxa: (singular - Taxon): units of taxonomic hierarchy; e.g., order, family, genus, species, variety.

Trophic: relating to fertilization, food and feeding in biological systems.

Tychoplankton: organisms of the stream or lake bottom occupying the plankton accidentally; usually motile over or resting upon the bottom but not attached.

Zooplankton: the animal component of the plankton.

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